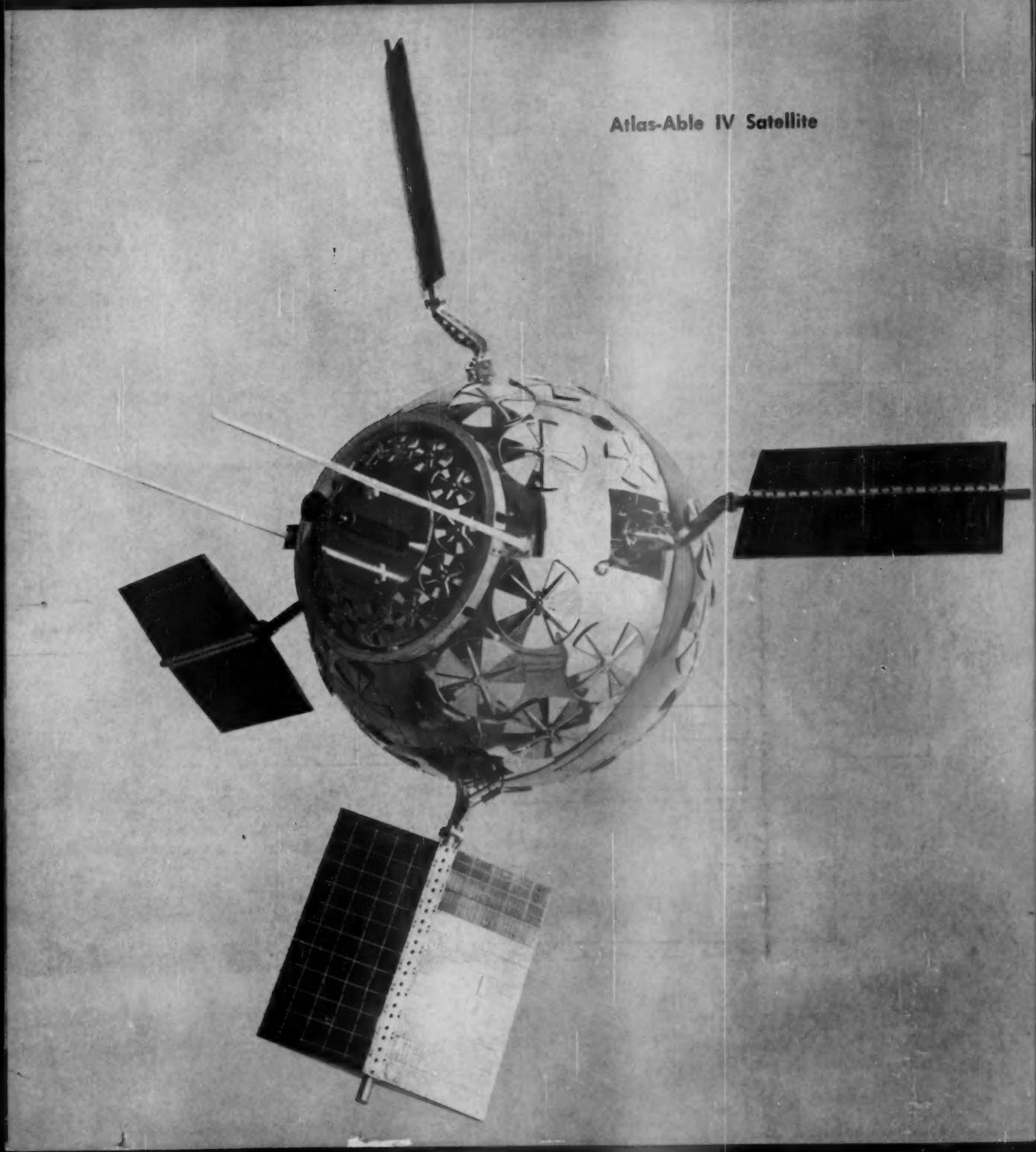
Aviation Week

Including Space Technology

December 14, 1959

Atlas-Able IV Instrumentation Detailed



Atlas-Able IV Satellite

The 880 Jet-Liner, latest to be produced, is the only jet transport to meet every performance estimate! Creative engineering • dramatic design • traditional craftsmanship • unmatched elegance • power by General Electric for superior speed—the world's fastest passenger plane! With these advantages, the 880, built by Convair, a Division of General Dynamics Corporation, *adds up* to the Jet-Liner that is *years ahead for years to come!*

CONVAIR
A DIVISION OF **GENERAL DYNAMICS CORPORATION**

First to offer Convair 880 or 600 Jet-Liner service will be TWA, DELTA, TRANSCONTINENTAL (Argentina), REAL-AEROVIAS (Brazil), S.A.S., SWISSAIR, AMERICAN, C.A.T. (Formosa)

From the present USAF production ATLAS
CONVAIR has developed a

Basic Research Vehicle

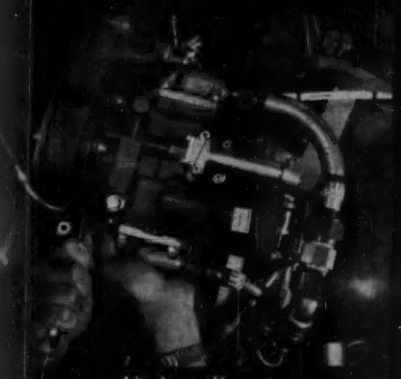
...a missile booster for peaceful scientific space exploration

VICKERS INCORPORATED supplies hydraulic pumps which provide reliable power for the vital job of gimballing all engines on the mighty Atlas. These pumps are part of a complete line of fluid power equipment with an industry-wide reputation for thorough engineering and precision manufacturing.

VICKERS, as a result of its participation in missile and spacecraft programs, has developed cryogenic, hot gas and other types of auxiliary power systems. Also available: electrical generating systems, actuator systems, and miniaturized power packages with integral controls.

Call in your Vickers Application Engineer to discuss your airborne fluid power requirements... components or systems.

Write for Bulletin A5233



Vickers Pump Being Installed on Atlas

AERO HYDRAULICS DIVISION
VICKERS INCORPORATED
DETROIT 32, MICHIGAN

division of
SPERRY RAND CORPORATION

ANTENNA PROBLEMS?

ASK KENNEDY!

A TRACKING ANTENNAS — *A 60-foot satellite tracker points skyward. 28- and 84-foot models also available.*

B SCATTER ANTENNAS — *One end of a scatter link showing two 120-foot antennas. 28- and 60-foot models are also available.*

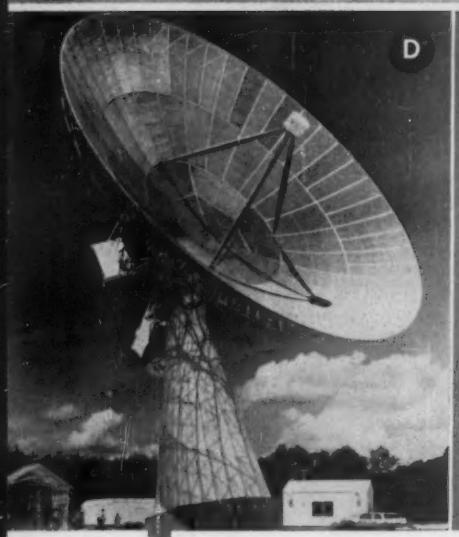
C RADAR ANTENNAS — *A giant radar antenna forerunner to the BMEWS Program. Dozens of conventional types are also available.*

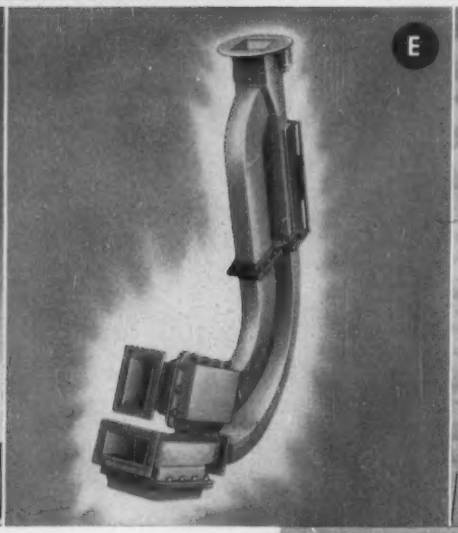
D RADIO TELESCOPES — *An 84-foot radio telescope listens to the heavens whisper. 28- and 60-foot models are also available.*

E WAVEGUIDE COMPONENTS — *A dual polarized feed with two waveguide inputs. Other large size components include many types of horns, duplexers, transitions, straight sections and bends.*

F FIELD SERVICE — *Kennedy Field Service engineers erect an 84-foot radio telescope. Other services include site selection, constructon, personnel training and servicing.*

G RESEARCH AND DEVELOPMENT — *Kennedy's antenna service includes basic R & D in microwave propagation.*





THE solution to antenna problems begins when someone says: "Let's ask Kennedy!"

A few of the many reasons why are shown on this page. These Kennedy antennas are setting new standards for all-weather reliability and versatility wherever they serve throughout the free world.

Kennedy antennas come in many shapes and many sizes. But whatever the type, and whatever the conditions under which it must serve, Kennedy can offer a design that fully measures up to specifications.

Kennedy Field Service engineers are available to install antennas anywhere in the world. It's a part of the complete, integrated service that is still another reason why more and more people in electronics are "asking Kennedy" about antenna problems.

ANTENNA EQUIPMENT

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COHASSET, MASSACHUSETTS Evergreen 8-1200

West Coast Affiliate . . .

SATELLITE KENNEDY, INC. of CALIFORNIA

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Down-to-earth SOLUTIONS *to out-of-this-world* PROBLEMS

Tracking Antennas-Radio Telescopes-Radar Antennas

"Trans-Horizon" Antennas-Tropospheric Scatter

Ionospheric Scatter

AVIATION CALENDAR

Dec. 26-30—Sixth King Orange International Model Plane Meet, Miami, Fla.

Dec. 26-31—Annual Meeting, American Assn. for the Advancement of Science, Morrison Hotel, Chicago, Ill.

Jan. 11-13—Sixth National Symposium on Reliability and Quality Control in Electronics, Statler-Hilton Hotel, Washington, D. C.

Jan. 11-15—1960 Annual Meeting, Society of Automotive Engineers, Sheraton-Cadillac and Statler Hotels, Detroit, Mich.

Jan. 12-16—16th Annual Technical Conference, Society of Plastics Engineers, Conrad Hilton Hotel, Chicago, Ill.

Jan. 18-21—Sixth Annual Meeting, American Astronautical Society, Statler-Hilton Hotel, New York, N. Y.

Jan. 20-22—Capitalizing on Technology, Special Research and Development Conference, American Management Assn., Roosevelt Hotel, New York, N. Y.

Jan. 25-28—28th Annual Meeting, Institute of the Aeronautical Sciences, Hotel Astor, New York, N. Y. Honors Night Dinner, Jan. 26.

Jan. 28-29—Solid Propellants Conference, American Rocket Society, Princeton University, Princeton, N. J.

Feb. 1-4—Winter Conference & Exhibit, Instrument Society of America, Rice Hotel and Sam Houston Coliseum, Houston, Tex.

Feb. 3-4—Sixth Annual Midwest Welding Conference, Illinois Tech Chemistry Bldg., Chicago, Ill. Sponsors: Armour Research Foundation of Illinois Institute of Technology; Chicago Section, American Welding Society.

Feb. 3-5—1960 Winter Convention on Military Electronics, Institute of Radio Engineers, Biltmore Hotel, Los Angeles.

Feb. 10-12—Seventh Annual Solid-State Circuits Conference, Philadelphia, Pa. Sponsors: Institute of Radio Engineers; Ameri-

(Continued on page 6)

AVIATION WEEK Including Space Technology

December 14, 1959

Vol. 71, No. 24

Published weekly with an additional issue in December by McGraw-Hill Publishing Company. James H. McGraw (1860-1948), Founder. See panel below for directions regarding subscription or change of address. **Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y.** Publication Offices, 99-129 North Broadway, Albany 1, N. Y. Donald C. McGraw, President; Joseph A. Gerardi, Executive Vice President; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary. Officers of the Publications Division: Nelson L. Bond, President; Harry L. Waddell, Senior Vice President; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator.

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Single copies 75¢. Subscription rates—United States and possessions, $7 one year. Canada $8 one year. All other countries, $20 one year.

Second class postage paid at Albany 1, N. Y. Printed in U. S. A. Title registered in U. S. Patent Office.
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Quality control of precision sheet metal components for jet engines, missiles, air frames and similar end products demands the total resources of qualified men, methods and machines. At Lavelle, experienced craftsmen use a variety of inspection techniques and equipment at every stage of production . . . from tool control to final piece inspection . . . to maintain quality control of critical parts to exacting specifications.

Lavelle specializes in producing weldments and assemblies made of titanium, aluminum, magnesium, stainless steel and nickel alloys. X-ray, Zyglo, and Magnaflux methods of non-destructive inspection are certified and used to control material and weld quality. Close supervision by Lavelle inspection specialists assures consistent component quality . . . at a cost related to your standards.

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Where you need the strength of a solid rivet—in those impossible, blind installations—the new Cherry 3/32" Self-Plugging Rivet is the answer.

These Cherry miniature self-plugging rivets are now available in the industry-proven Cherry High Clinch configuration. Ideal for delicate installations in thin sheets with no damage to surrounding material.

A complete line of Cherry 3/32" Hollow Pull-Thru rivets is also available with either universal or 100° countersunk head.

For technical information write to Townsend Company, Cherry Rivet Division, P.O. Box 2157-N, Santa Ana, California.

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In Canada: *Parmenter & Bulloch Manufacturing Company, Limited, Gananoque, Ontario*

AVIATION CALENDAR

(*Continued from page 5*)

can Institute of Electrical Engineers; University of Pennsylvania.

Feb. 16-18—First National Symposium on Nondestructive Testing of Aircraft and Missile Components, Hilton Hotel, San Antonio, Tex. Sponsors: Southwest Section, Society for Nondestructive Testing; Southwest Research Institute.

Mar. 9-11—Conference on the Mechanical Properties of Engineering Ceramics, North Carolina State College, Raleigh, N. C. Sponsors: North Carolina State College School of Engineering; Office of Ordnance Research, U. S. Army.

Mar. 10-11—National Flight Propulsion Meeting (classified), Institute of the Aeronautical Sciences, Cleveland, Ohio.

Mar. 23-25—Symposium on Optical Spectrometric Measurement of High Temperatures, University of Chicago, Chicago, Ill. Sponsors: University of Chicago's Applied Science Laboratories; Jarrell-Ash Co.; National Science Foundation.

Apr. 6-8—Structural Design of Space Vehicles Conference, Biltmore Hotel, Santa Barbara, Calif. Sponsor: American Rocket Society's Structures and Materials Committee.

Apr. 6-8—1960 National Meeting "Hyper-Environments—Space Frontier," Institute of Environmental Sciences, Biltmore Hotel, Los Angeles, Calif.

Apr. 19-21—International Symposium on Active Networks and Feedback Systems, Engineering Societies Bldg., New York, N. Y. Sponsors: Polytechnic Institute of Brooklyn; Department of Defense Research Agencies; Institute of Radio Engineers.

Apr. 20-22 — National Symposium on Manned Space Stations, Institute of the Aeronautical Sciences, Ambassador Hotel, Los Angeles, Calif. Cosponsors: National Aeronautics and Space Administration; the Rand Corp.

Apr. 21-22—Southwest Metals & Minerals Conference "Metals and Materials for the Space Age," American Institute of Mining, Metallurgical and Petroleum Engineers, Ambassador Hotel, Los Angeles.

Apr. 25-29—41st Annual Convention and Exposition, American Welding Society, Biltmore Hotel and Great Western Exhibit Center, Los Angeles, Calif.

Apr. 27-28—National Meeting on Space Age Materials, Cincinnati Chapter of the American Society for Metals, Sheraton Gibson Hotel, Cincinnati, Ohio.

May 9-11—1960 Symposium of the Institute of Radio Engineers' Professional Group on Microwave Theory and Techniques, Hotel del Coronado, San Diego, Calif.

May 9-13—Second Southwestern Metal Congress and Exposition, American Society for Metals, Sheraton Dallas Hotel and State Fair Park, Dallas, Tex.

May 10-12—1960 Electronic Components Conference, Willard Hotel, Washington, D. C. Sponsors: Institute of Radio Engineers' Professional Group on Component Parts; American Institute of Electrical Engineers; Electronic Industries Assn.; Western Electronic Manufacturers Assn.

FROM LAGRANGIAN TO LIFT-OFF

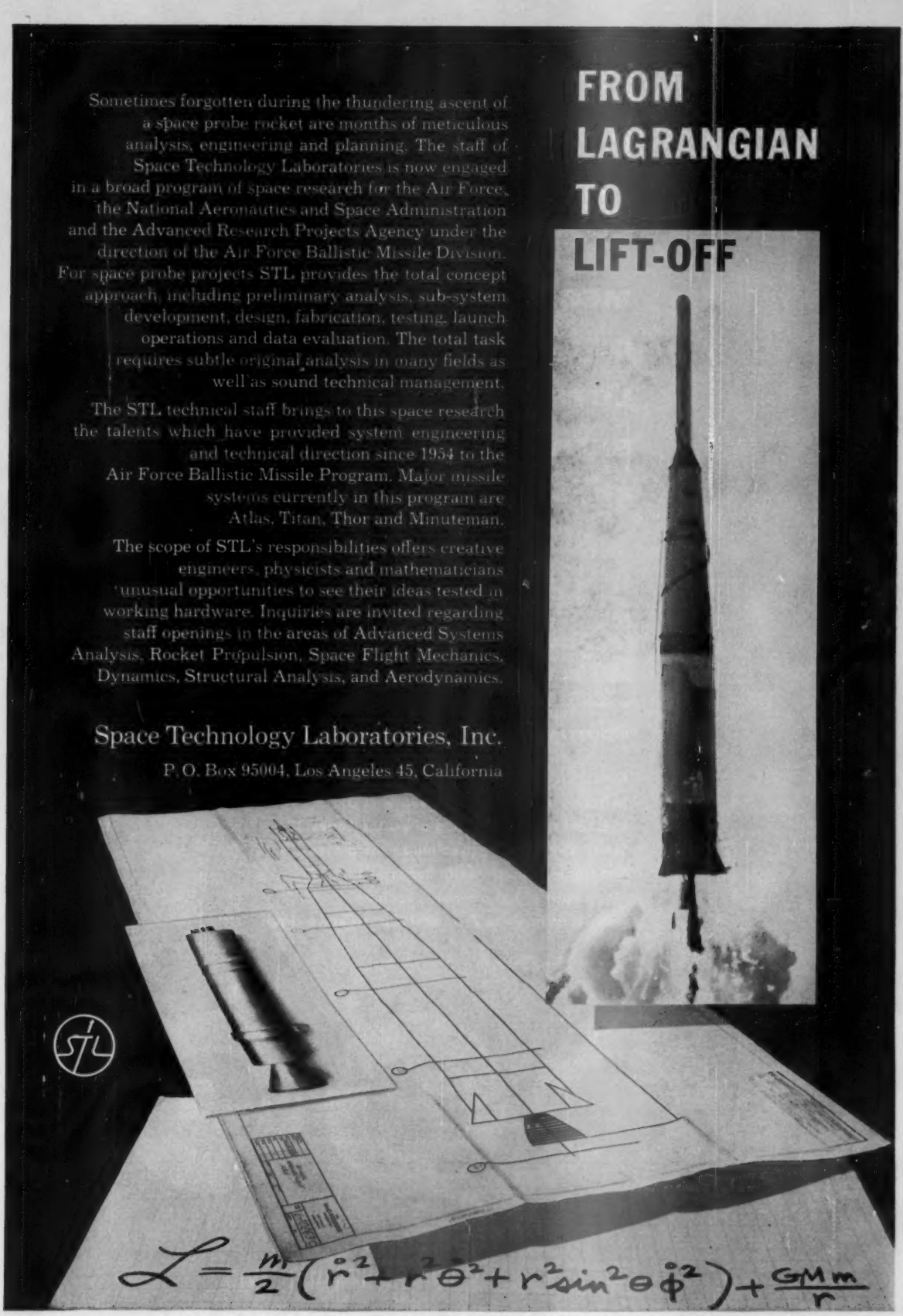
Sometimes forgotten during the thundering ascent of a space probe rocket are months of meticulous analysis, engineering and planning. The staff of Space Technology Laboratories is now engaged in a broad program of space research for the Air Force, the National Aeronautics and Space Administration and the Advanced Research Projects Agency under the direction of the Air Force Ballistic Missile Division. For space probe projects STL provides the total concept approach, including preliminary analysis, sub-system development, design, fabrication, testing, launch operations and data evaluation. The total task requires subtle original analysis in many fields as well as sound technical management.

The STL technical staff brings to this space research the talents which have provided system engineering and technical direction since 1954 to the Air Force Ballistic Missile Program. Major missile systems currently in this program are Atlas, Titan, Thor and Minuteman.

The scope of STL's responsibilities offers creative engineers, physicists and mathematicians unusual opportunities to see their ideas tested in working hardware. Inquiries are invited regarding staff openings in the areas of Advanced Systems Analysis, Rocket Propulsion, Space Flight Mechanics, Dynamics, Structural Analysis, and Aerodynamics.

Space Technology Laboratories, Inc.

P. O. Box 95004, Los Angeles 45, California



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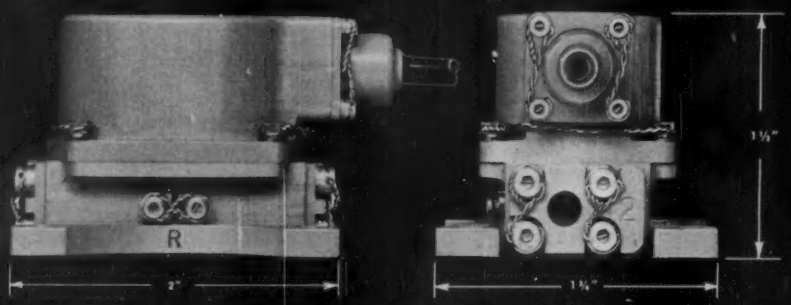
0.32 lb (TOTAL WEIGHT)

MECHANICAL FEEDBACK
DRY MOTOR
LOW FLOW CONTROL
SERVOVALVE



"INDUSTRY STANDARD MOUNTING DETAILS"

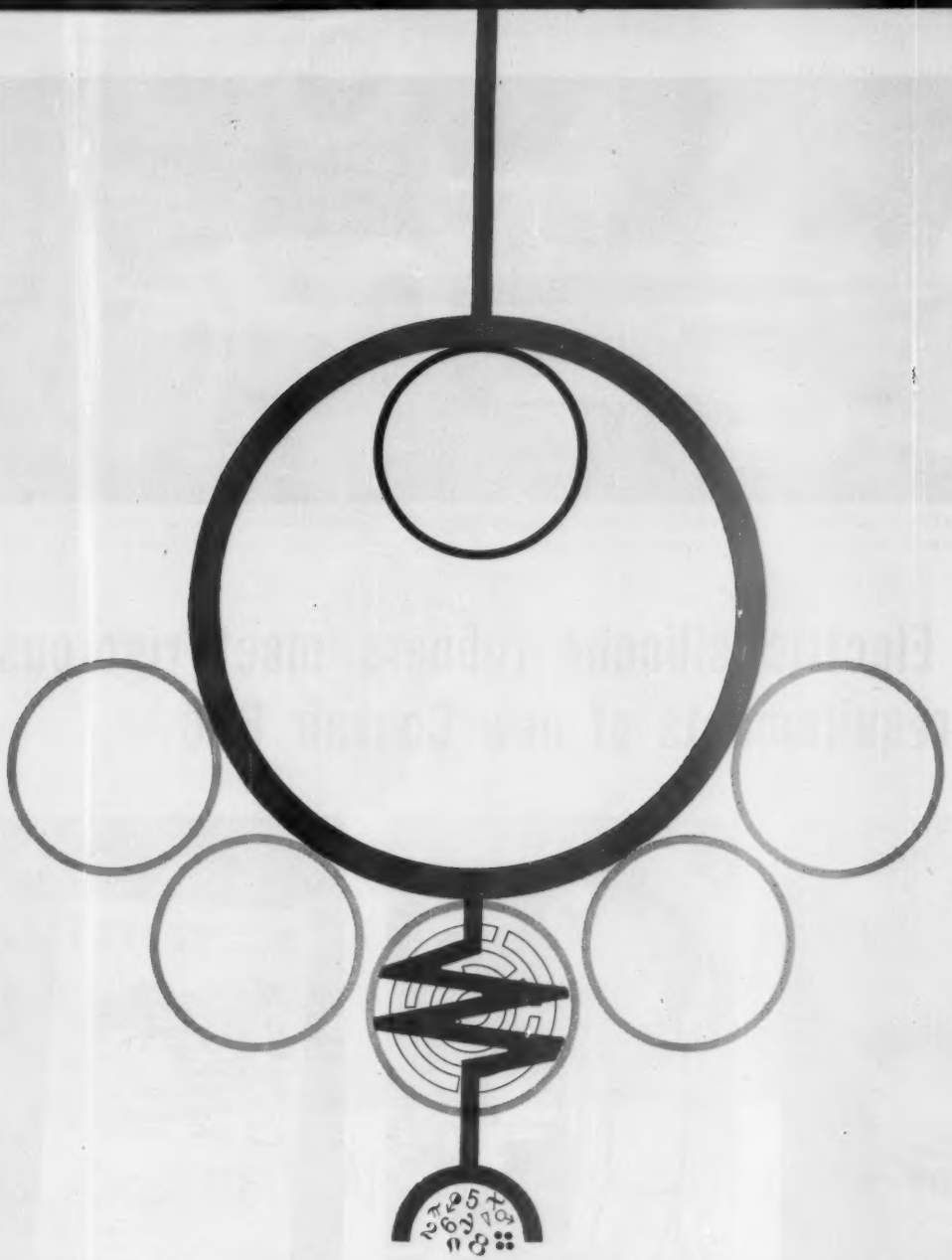
For critical applications where outstanding performance must be achieved with a minimum of weight, Moog offers the Series 30 Servovalve. These valves utilize the *proven* first stage of the standard Series 31 and 32 Moog valves, and are now available with rated flows to 7 cis at 1000 psi valve drop.

WRITE FOR PRODUCT BULLETIN 113

from **MOOG:**

MOOG SERVOCONTROLS, INC.

PRONER AIRPORT, EAST AURORA, NEW YORK



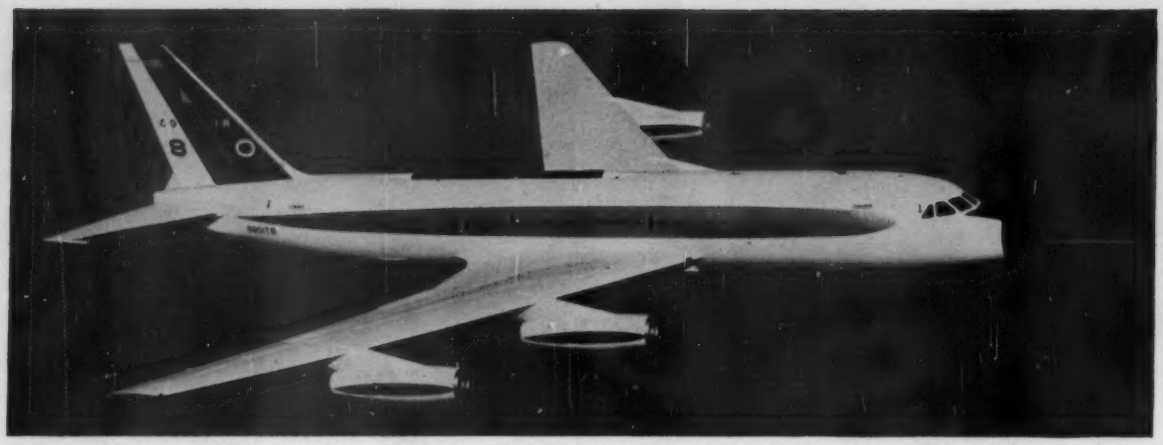
COMPUTATION—PRIMED FOR THE TEAM PROGRAM

BURROUGHS CORPORATION IS UNIQUELY PREPARED TO CAPTAIN OR CREW THE CONTRACT TEAM PROGRAM. ITS MAJOR CONCERNS ARE COMPUTATION—AND COOPERATION. THE FORMER RANGING FROM BASIC RESEARCH AND SYSTEMS ENGINEERING THROUGH PRODUCTION TO FIELD SERVICE; THE LATTER DEMONSTRATED BY EFFECTIVE INTERFACING RELATIONSHIPS AND INTER-TEAM COMMUNICATION. WITH THE BENEFIT OF BOTH, THE TEAM APPROACH TO ANY SPACE AGE PROBLEM IS SMOOTHER, STRONGER, AND ABOVE ALL, SUCCESSFUL.

Burroughs

Burroughs Corporation

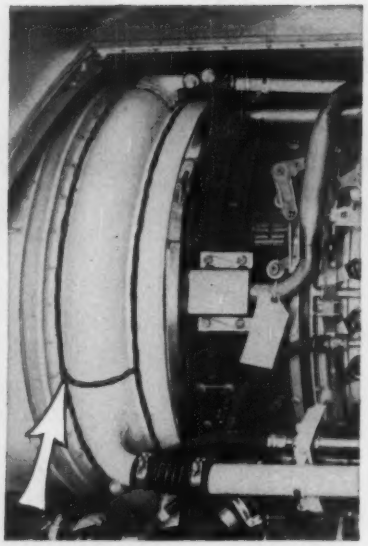
"NEW DIMENSIONS | in computation for military systems"



Flex-support door seal designed by Convair is typical of advance design features of the 880. General Electric silicone rubber—with its outstanding resistance to temperatures, ozone and aging—is used extensively on the General Dynamics Convair 880.

General Electric silicone rubbers meet rigorous requirements of new Convair 880

Unique silicone rubber door seal incorporating spring steel flex-support, a fail safe feature that eliminates the danger of seal collapse. General Electric SE-555, with twice the strength of regular silicone rubber, easily withstands flexing of integrally molded steel support. Over 600 wiping action and pressure cycling tests prove seal will meet all operational requirements.



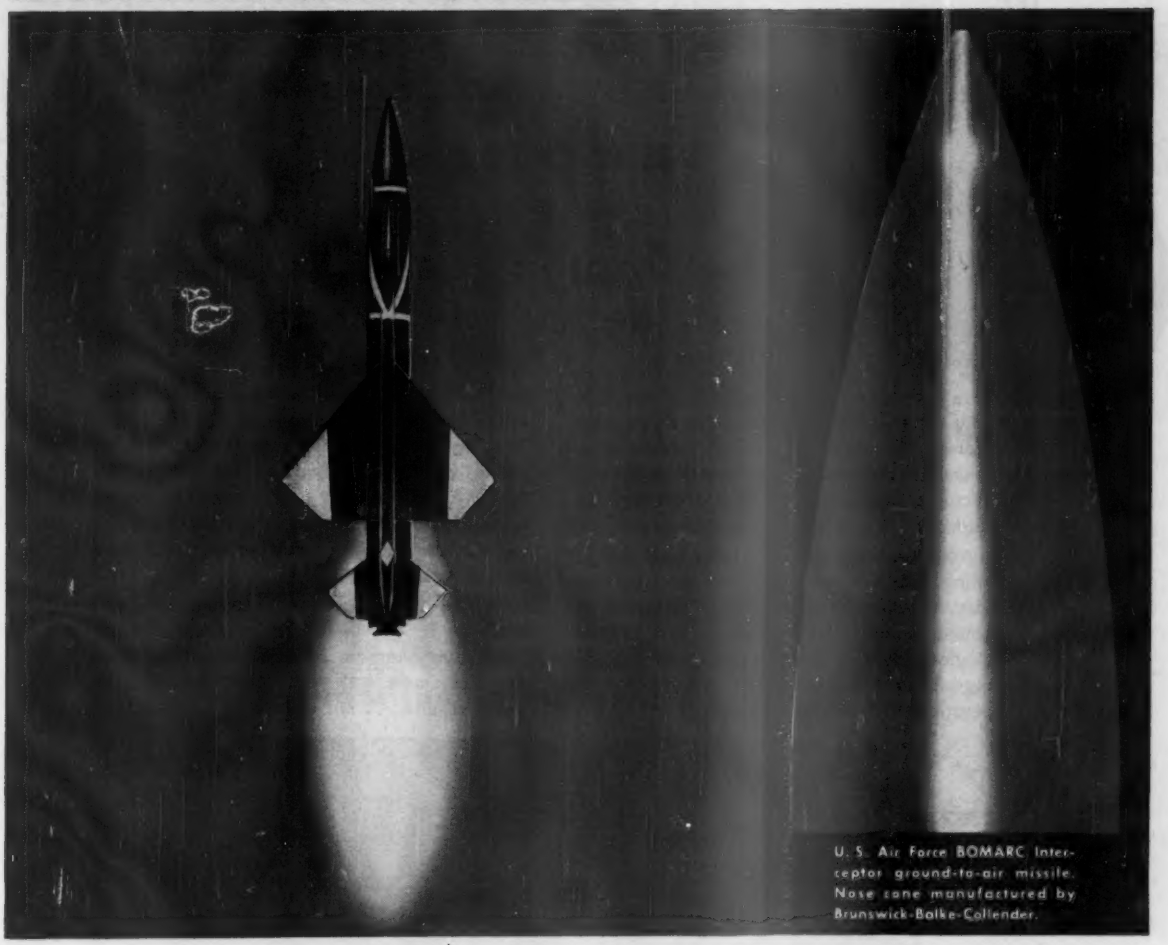
G-E RTV high-temperature sealant is used extensively in pylon and pod assemblies which hold G-E CJ805-3 jet engines. Liquid RTV (room temperature vulcanizing) silicone rubber is easily applied and cures without heat. RTV has excellent bond strength, good physical properties, plus resistance to temperature extremes (600°F and above), ozone, weathering, moisture, aircraft fuels and solvents.

Now available: New G-E Silicone Rubber Selector. This guide will help you quickly select the right silicone rubber to best meet your application requirements. In it you will find important data on applications, primary classes, typical properties and specifications. Tells how to specify the grade you want by AMS, ASTM or military specifications. Write for your free copy.

GENERAL ELECTRIC

Sector J1211, Silicone Products Department, Waterford, N. Y.

Naugatuck VIBRIN



U. S. Air Force BOMARC Interceptor ground-to-air missile. Nose cone manufactured by Brunswick-Balke-Collender.

Deadly BOMARC has nose cone of **VIBRIN®**

Heat generated by supersonic speeds is a critical factor in the selection of missile materials. High strength combined with light weight is a necessity. Formability, transparency to radar beams, and freedom from erosion are of vital importance.

For all of these reasons, the nose cone of the BOMARC is constructed of fiber glass-reinforced polyester resins VIBRIN 135 and 136A. These resins are ideal for the pre-impregnation method used by Brunswick. Most important, they proved to be the *only* polyester resins tested that were *able to withstand the high temperatures encountered.* Where competitive resins lost one or more of their properties at or below 500 F., VIBRIN was unaffected at temperatures far above.

The success of VIBRIN in this one application has been duplicated many times over in Brunswick products ranging from aircraft noses, doors, and panels to modern bowling and school furniture.

Look into VIBRIN for your own product needs. Discover for yourself the many advantages these advanced polyester resins offer, not only over other materials, but over other resins as well. Write or call today for full information.

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We produce results!

AERONCA designs—tools—produces complex brazed stainless honeycomb structures

There is much talk in the industry about state-of-the-art capability in stainless honeycomb sandwich fabrication. Actual *production experience* in this new field of exotic materials and structures still is limited to a relatively few companies. *And Aeronca is one of them.*

At Aeronca, we have fully integrated design, tooling and production facilities in operation today. A pioneer in stainless honeycomb development, Aeronca has acquired advanced technological knowledge from proprietary R&D programs and production of components for operational air weapon systems.

The supersonic speed brake assembly illustrated below is an example of our capability. This design, one of the most intricate brazed stainless structures produced to date, is 75" long, 46½" wide and 3½" deep. Its complex cross-section required extremely precise forming and machining as well as special tooling and process control.

Whatever your honeycomb requirements, you can save time, expense and headaches by utilizing our extensive experience and facilities. Our customers will verify that *Aeronca produces results . . . not claims!*

This 120" curved section is typical missile structure.

Stainless honeycomb components for B-58 "Hustler."

Top view of new speed brake assembly.

Operational expansion has created openings for additional senior engineers. Write to W. W. Gordinier, Personnel Manager.

AERONCA

aeronca manufacturing corporation

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BTES-AC

WHEN IT COMES TO SHIELDED WIRE

SLIDE on the ferrule

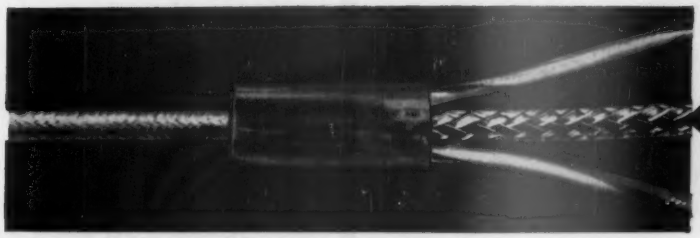
SLIP in the ground taps

CRIMP the three together

SNAP on the insulation

PRESTO!

the best insulated ferrule you can buy



How's that for speed! And the post-insulation of the Termashield Shielded Wire Ferrule is easily and quickly accomplished . . . you eliminate close tolerance cable stripping required by other techniques . . . you eliminate blind probing of taps into other type ferrules . . . you eliminate solder and burnt cable . . . you eliminate lost time . . . you eliminate doubt.

For positive attachment, top reliability, unbeatable speed and tangible economy, get A-MP Post-Insulated Termashield Shielded Wire Ferrules.

Write for more information.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

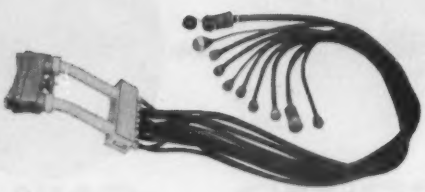
A-MP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Japan

Cable assemblies by BENDIX

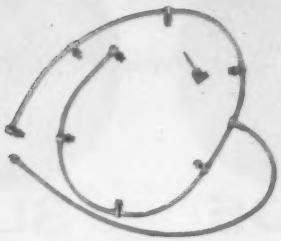
Specialized designs for the most exacting requirements

The versatility of design and reliability of performance offered by Bendix* Cable Assemblies result from over a quarter century of precision manufacturing in this field. Our outstanding research and design facilities are available for custom designing cable assemblies to meet your specialized requirements on each installation. Cable assemblies shown are typical Scintilla Division developments in cabling for aircraft, electronic and missile applications.

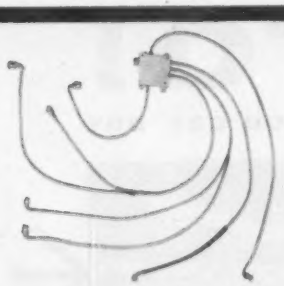
*REG. U. S. PAT. OFF.



MISSILE CONTROL CABLE: This cable is fabricated using both Benseal® (a plastic molded covering) and Bendix electrical connectors. Protects vital circuitry controlling the firing of missiles.



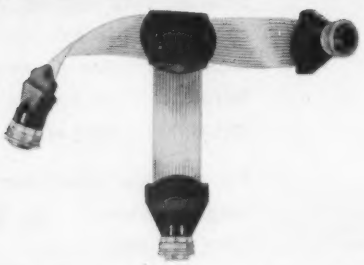
THERMOCOUPLE HARNESS: Flexible, completely sealed and suitable for continuous operation in ambient temperatures of —65°F to 1500°F. Thermocouples are singly detachable and the sealed harness eliminates any chance of trouble from altitude, moisture or other contaminants.



CONTROL HARNESS: This configuration, encased and sealed in metal braid and complete with junction box, can safely withstand the adverse effects of engine environment such as heat, vibration, and oils.

FUEL CELL CABLE: Safely conducts electricity to fuel control valves, pumps, switches and gaging devices immersed within fuel cells. Features: unbroken stainless steel bellows type conduit, double layer protection between current carrying conductors, stainless steel integral connector shells.

HEAVY DUTY CABLE: Ground support cable assembly built and designed for hard usage at missile launching sites. Heavy duty moldings and a tough neoprene tubing combine to resist wear.



RIBBON CABLE: Ribbon type cable terminated to both standard MS or Bendix Pygmy® connectors. Advantages offered by this type of wiring include durability, performance, lightness, plus minimum space requirements.

Export Sales & Service: Bendix International Division, 205 E. 42nd St., New York 17, N.Y. Canadian Affiliate: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec

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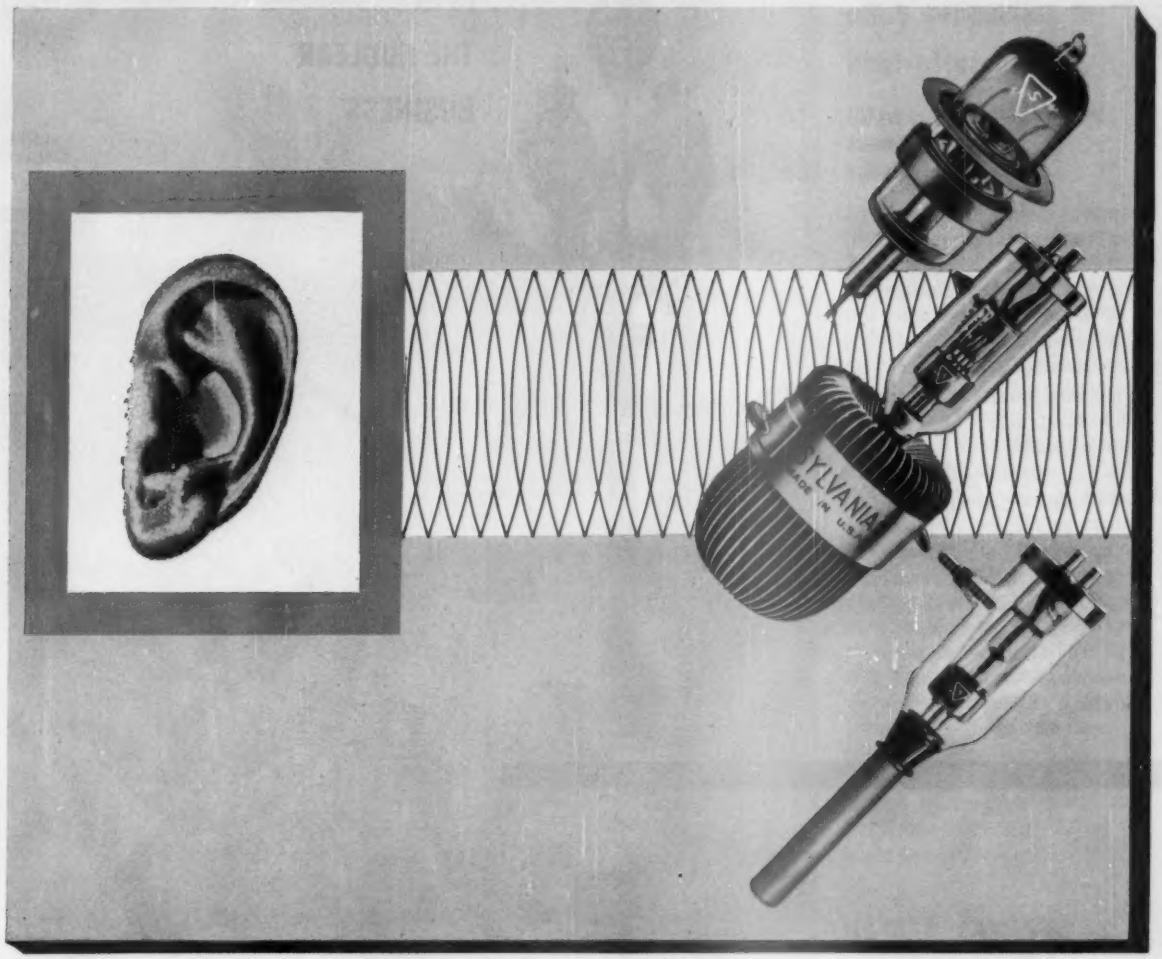
SIDNEY, NEW YORK

Bendix
AVIATION CORPORATION

SYLVANIA GOLD BRAND TUBES...



and the new standard in COMMUNICATIONS

Sylvania Gold Brand tubes are playing an important role in the continuing progress of communications. They have helped to establish new standards of reliable performance in military, commercial and industrial communications equipment. Now, in keeping with this outstanding record, Sylvania offers a line of transmitting tubes made in the tradition of the famous Gold Brand line.

AM, FM, TV, VHF, UHF—whatever the service, there is a Sylvania transmitting tube to fill the bill. And it will meet your requirements with greater reliability because of Sylvania's Gold Brand background. This means extra quality controls and stringent specification requirements for premium efficiency from every tube. The end result is less down time and more dependable communications.

Here are some of the more popular classes of Sylvania Communication Tubes:

- **High Vacuum Amplifiers**
- **Planar Triodes**
- **Lighthouse Triodes**
- **Modulator Amplifier and Oscillator types —forced air, convection or water cooled**
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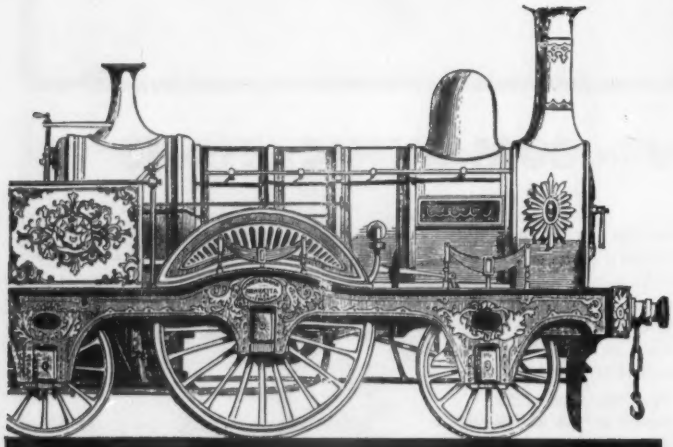

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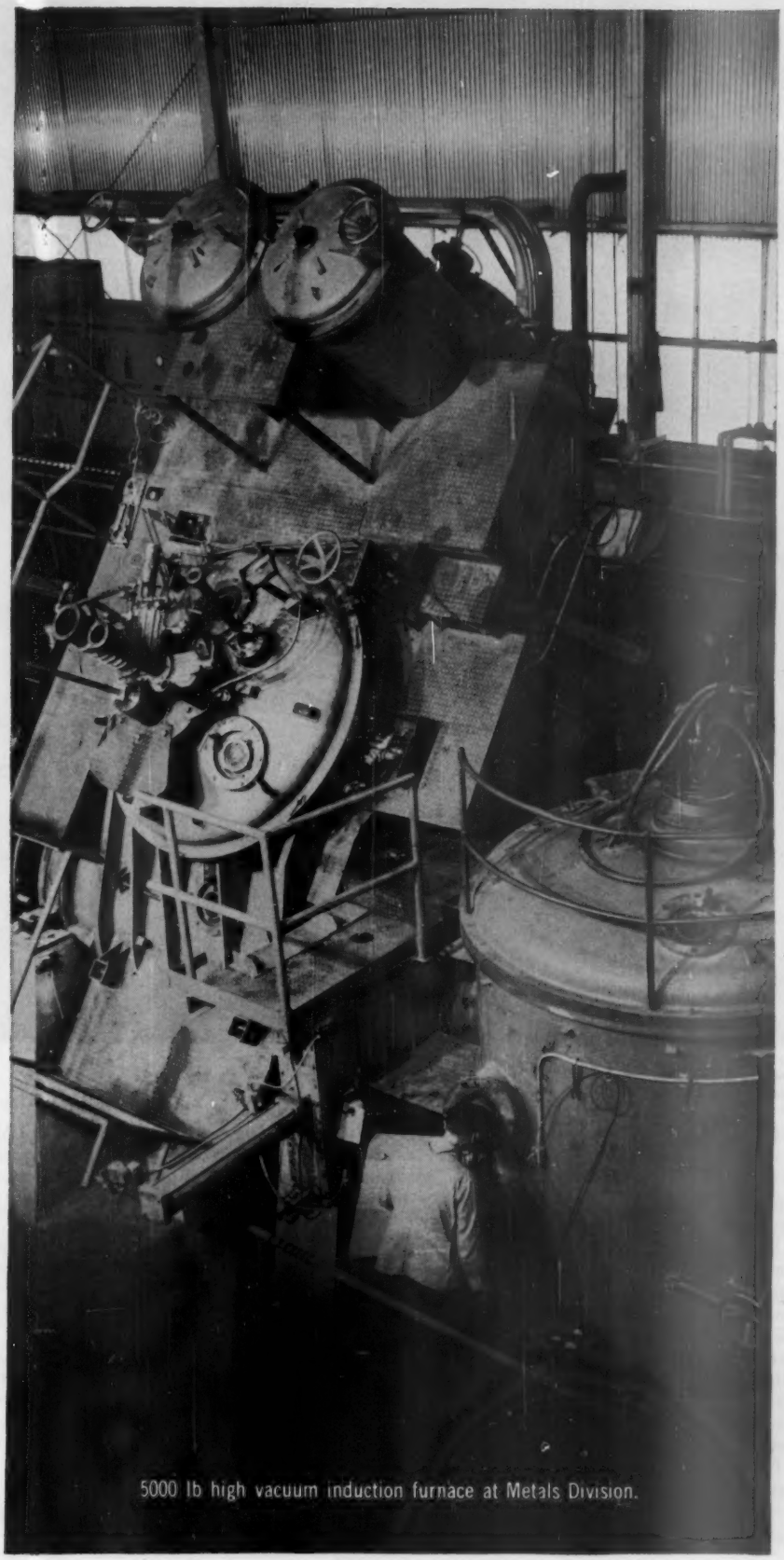

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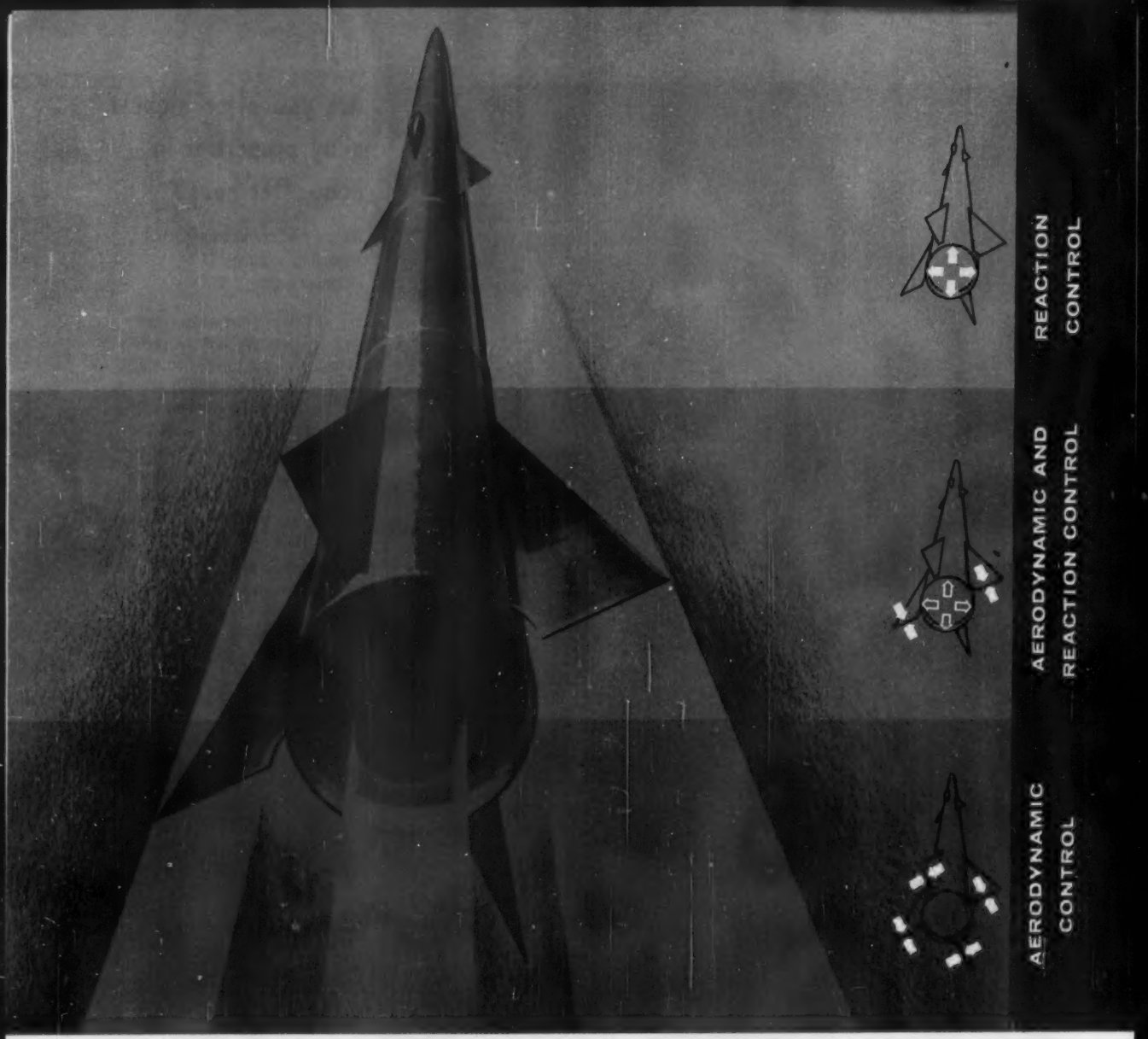

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December 14, 1959

Aviation Week
Including Space Technology

Vol. 71, No. 24
Member ABP and ABC

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COVER: National Aeronautics and Space Administration Atlas-Able IV payload shows propeller-like devices for controlling internal heat; antennas, vernier rocket for providing final velocity increment and later velocity corrections. Payload was destroyed after glass fiber fairing, a new design, failed in a launch attempt Nov. 26 (AW Dec. 7, p. 31). Satellite was to have been put into a low orbit around the moon. Another payload exists but no launching rocket has been ordered. Project was one of a series being conducted for NASA by Air Force Ballistic Missile Division and Space Technology Laboratories, Inc. For other details, see p. 53.

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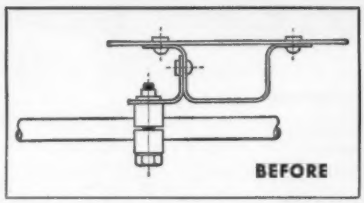

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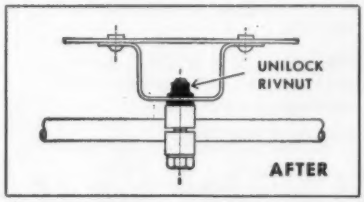

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EDITORIAL

Business in a Goldfish Bowl

Defense Secretary Thomas Gates, on assuming office, noted that the Pentagon was a goldfish bowl where all of its business, not screened by genuine military security considerations, should be open to public view. It is logical to assume, therefore, that all contractors doing business with the Pentagon are also conducting their operations in a goldfish bowl where eventually everything is and should be open to public scrutiny. The recent activities of the congressional investigating committee headed by Rep. Edward Hebert (D.-La.) should serve as a poignant reminder to those in the military services and defense industry executives who apparently forget such considerations.

An effective relationship between the military services and the industrial complex of this country has been growing in importance with the rapid advance in technology across the entire defense front in the past 20 years. The growing requirements on both ends of this military-industrial relationship involve many thorny problems that must be solved, as most other issues in the defense program must be, in a goldfish bowl of public scrutiny and in the final analysis by the weight of public opinion expressed through the ballot box.

The defense industry, of which aviation and its related technologies have been the major component, has been engaged on many fronts during the past few years battling against the strangling clutch of bureaucratic regulations that have squeezed its profits to the bone, prevented it from financing an adequate research and development program, boosted its administrative overhead through multiple audits and reviews and boosted the costs of financing its defense work.

Dozens of congressional committees, the General Accounting Office, the Army, Navy and Air Force auditors, the Renegotiation Board and now the Antitrust Division of the Justice Department are busy burrowing into the defense industry's affairs. Just testifying before congressional committees has become almost a full time occupation for many industry executives and their staffs.

It is extremely important that the industry conduct a vigorous and sustained counterattack against any bureaucratic regulations, unduly restrictive legislation or abuse of executive privilege that prevents it from doing an effective job in discharging its technical defense responsibilities. Yet, it is extremely difficult to conduct this type of campaign and convince Congress and the taxpaying public of its ability and integrity when some elements of both the military and industry team disport themselves in a manner more fitting for college sophomores on a house party than responsible officials of the government and large corporations occupying positions of public trust. The aviation industry, by its very nature, grew up in an atmosphere of close personal relationships between its key pioneers and the military men who were fighting so hard to win a place for the new technology in the defense spectrum. The early days of aviation also swathed it in something of a carnival air that was perhaps not at all inappropriate for the era of pylon racing and incredible feats of pushing men and structures far beyond where they really had any right to go.

Whether one clinks a nostalgic glass in fond memory or mutters "good riddance," these days are gone forever, and their ethics have little place in the modern military-industrial relationship. There are still appropriate places and occasions when this convivial spirit of yesteryear can be properly memorialized by those who participated in those stirring events. But it is no longer appropriate to conduct these rituals publicly and at the taxpayers' expense.

It would appear that men with sufficient intelligence and judgment to earn high military and industrial positions would be aware of this situation and, of course, many of them are. But no more than a reading of the record unfolded by the Hebert Committee or attendance at some of the semi-officially sponsored military-industry functions of the past few years provides clear evidence that this lesson has not been universally learned.

The public can hardly be blamed if they are not impressed by the sight of bemedaled generals swishing around Las Vegas, the gambling capital of the U.S., in white sports cars piloted by blonde chauffeurs financed by firms doing defense business. Nor can they be blamed for being overly skeptical of the "good clean fun" label on the shuttling of Pentagon brass to a Bahama resort and the inability of these generals to pay their own bills there. Nor does the industry, already badgered by one part of the Pentagon to drastically cut its overhead, appreciate the pressure from other portions of the Pentagon to pick up sizable tabs for large cocktail parties, dinners, equipment exhibits and other activities that can only be charged against overhead.

Unless the minority of officials in both the Pentagon and industry, who are still mentally bending pylons on long weekends in Cleveland, do some sober thinking on the fact that Pentagon business is conducted in a goldfish bowl and behave accordingly, they will continue to jeopardize the sincere efforts of the majority of responsible corporate and military officials who are fighting valiantly to improve the effective working relationship between the Pentagon and industry that is so vital to an adequate defense of this country and the free world.

—Robert Hotz

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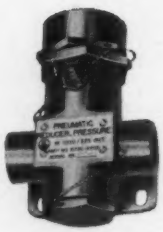

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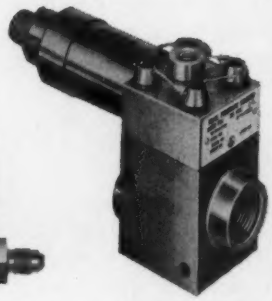

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Wallace E. Rianda and **David Bakalar**, directors, Epsco, Inc., Cambridge, Mass. Mr. Rianda is a vice president and general manager of Epsco-West, a division; Mr. Bakalar is president of Transitron Electronics Co.

Elbert G. Bellows, a director, The W. L. Maxson Corp., New York, N. Y. Mr. Bellows is vice president of the Contracts Division.

Croydon H. Hartley, a customer liaison manager, Los Angeles Division of Servomechanisms, Inc., Hawthorne, Calif. Until accepting this appointment, Mr. Hartley was president of the company's Canadian subsidiary and he continues as a director.

Roy H. Isaacs, vice president- government relations, Bendix Aviation Corp., Detroit, Mich. **Milo F. McCammon** succeeds Mr. Isaacs as general manager of the company's Eclipse-Pioneer Division, Teterboro, N. J.; **James E. Bevins** was named assistant general manager.

Ralph Mendel, a vice president of Radio Receptor Co., subsidiary of General Instrument Corp., has been named general manager of its new Advanced Development Laboratory, Westbury, N. Y. Also: **Arnold M. Wolf**, vice president, Engineering Products Division, Brooklyn, N. Y.; **Seymour D. Gurian**, vice president in charge of military marketing.

Clarence C. Pell, Jr., vice president in charge of the aviation department, Marine Office of America, New York, N. Y.

Group Capt. E. M. T. Howell, director of air armament research and development, British Ministry of Aviation, succeeding **Air Cmdr. R. H. E. Emson.**

Brig. Gen. F. C Tharin, commander of the Second Marine Aircraft Wing, Cherry Point, N. C., succeeding **Maj. Gen. A. F. Binney**, now director of Marine Aviation.

Honors and Elections

Paul A. Kennedy, vice president of Southwest Airmotive Co., has been elected president for 1960 of the Aviation Distributors and Manufacturers Assn. Elected ADMA vice presidents: **E. H. Fitch** of B. F. Goodrich Aviation Products, and **George R. Galipeau** of Van Dusen Aircraft Supplies.

V. A. Kropff, chairman, and **Paul J. Rodgers**, vice chairman, of the Public Affairs Committee of the Air Transport Assn. of America. Mr. Kropff is assistant vice president-executive projects, Braniff Airways; Mr. Rodgers is director of public and interline relations, Ozark Air Lines.

Dr. Harry Nyquist, staff scientist in the Research & Development Division of The W. L. Maxson Corp., will receive the Institute of Radio Engineers' 1960 Medal of Honor "for fundamental contributions to a quantitative understanding of thermal noise, data transmission and negative feedback."

The Council of the International Civil Aviation Organization has voted to bestow the first **Edward Warner Award** posthumously on **Dr. Albert Plesman**, founder and president of KLM Royal Dutch Airlines.

(*Continued on page 154*)

INDUSTRY OBSERVER

► Air Force decision is expected soon on an interceptor to fill void left by recent F-108 cancellation. Still under consideration are modified versions of the McDonnell/Navy F4H and the Convair F-106 refitted with new Hughes fire control system with extended range radar and the GAR-9 air-to-air missile as well as interceptor versions of the Convair B-58 and Navy's North American A3J.

► **India is studying four turbine-powered helicopters for use by its air force in high altitude supply operations in the Himalayan mountain areas along the Chinese border. Sikorsky Aircraft will demonstrate the S-62 this week in New Delhi. Britain's Westland Wessex is considered a strong contender. Saunders-Roe also is in the running with the P.531, and the French have an entry in the Sud Alouette. India is sounding out Bell Aircraft and the West Germans for possible contenders. India regards its need as urgent in view of its border dispute with China, and speed of delivery will be an important element. U. S. sources expect a relatively small order, at least initially—perhaps fewer than 10 ships.**

► Fighter choice in the second phase of the Swiss air force's re-equipment program reportedly has been narrowed to three aircraft—Sweden's Saab Draken J35A, France's Dassault Mirage III and Italy's Fiat G. 91. Other aircraft originally under consideration included the Lockheed F-104 and Grumman F11F-1F (AW Oct. 26, p. 103). Three-man study group from the Swiss air force left Berne last week to visit the Saab factory at Linkoeping.

► **USAF decision to cut back on its B-70 Mach 3 bomber development program (AW Dec 7, p. 26) means that the Convair B-58 Mach 2 bomber production program will be continued in Fiscal 1961 with funding for about 30 aircraft. The Fiscal 1960 B-58 program already has been cut from the original 32 aircraft programed to 20, rescinding President Eisenhower's Fiscal 1960 budget message boast that the B-58 production program would be increased this year over the Fiscal 1959 budget. Strategic Air Command has taken delivery on its first B-58 and plans to have its first complete B-58 wing in operation by mid-1960. SAC will now get a total of three B-58 wings with the strength of each wing cut from the standard 45 aircraft to less than 30 per wing.**

► Air Force plans to evaluate the solo optical guidance system developed by Chicago Aerial Industries for possible use with its White Lance version of the Navy Bullpup tactical air-to-surface missile under development by Martin-Orlando. Guidance system is simple, lightweight.

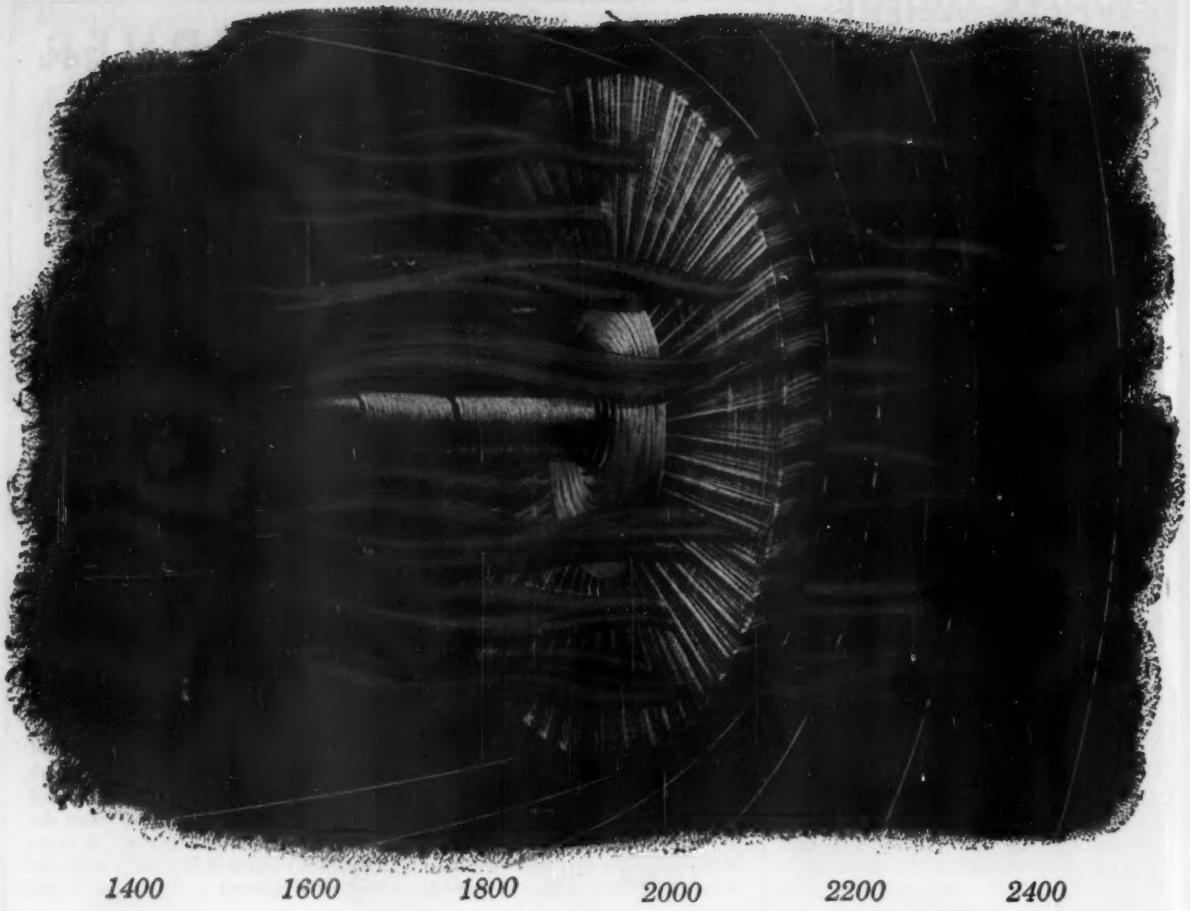
► **Low-cost infrared-guided air-to-air missile is being developed in Italy for possible use by the Italian air force. Missile's designation is C-7.**

► Dornier plans to demonstrate its single-engine all-metal Do.27 STOL aircraft during a two-month tour of the U. S. next spring. Itinerary of the tour is now being arranged. The four-to-six-place aircraft is powered by a six-cylinder Continental or Lycoming engine developing 230 hp. and 274 hp. respectively. Cost, depending upon the model, runs from $22,000 to $27,000 (AW Aug. 3, p. 104).

► **Soviet military officials claim that the single-jet E66 aircraft, which recently established a world speed record by averaging 1,484 mph. (AW Nov. 9, p. 30), actually attained a speed of 1,555 mph. on one of its runs. The E66, apparently a Sukhoi delta fighter, flew at an altitude of approximately 44,290 ft. during the record-breaking trial runs.**

► Mitsubishi hopes to manufacture the Sikorsky S-61, Kawasaki the Vertol 107-2, under license in Japan. Both firms are expected to apply to the Ministry of International Trade and Industry for permission to negotiate with the U. S. firms for domestic production of the two helicopters.

► **Air Force is considering basing in England all spares for the Douglas Thor intermediate range ballistic missile not required for U. S. satellite programs and Royal Air Force training firings from Vandenburg AFB, Calif.**



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Washington Roundup

Patents and Big Business

A report to Congress by the Justice Department expressing concern over the concentration of technological know-how in a few large corporations through military research and development contracts is behind hearings on patent policy started last week by a Senate Small Business Subcommittee on monopoly, headed by Sen. Russell Long (D.-La.).

In a letter to Long, noting a heavy concentration of military experimental and developmental contracts in about 25 firms, Acting Assistant Attorney General Robert Bicks of the Antitrust Division observed:

"Advantages accruing to any company performing government research are numerous. First, it gets a fee for the job. Beyond that, it gains know-how in new products developments, or in the use of new raw materials and processes to manufacture existing products. . .

"The company performing research may further benefit from resulting patents, by obtaining a legal monopoly over the subject of its invention—the power to exclude others from the field. Moreover, companies able to have important technical research programs financed for them can attract scientists and engineers, providing a staff for the future. During nationwide shortage of the scientifically trained, this is a substantial advantage. Finally, government work may give access to vital restricted data, not available generally for sound security reasons."

In 1947, the Justice Department urged full government ownership of all patents resulting from government contracts. Under the Eisenhower Administration, the department so far has been unwilling to endorse such a drastic measure. Justice, in cooperation with Defense Department and other interested agencies, has a study under way and has asked Congress to withhold any legislative action until this study is completed.

Bicks emphasized the effectiveness of antitrust enforcement. Compulsory licensing under a 1956 consent decree of patents that International Business Machines Corp. had amassed in electronic and mechanical data processing equipment, he reported, has resulted in competition by many licensees and "has aided the rapid growth of this modern industry."

Disarmament Study Proposed

Outlook is that disarmament proposals will figure prominently in the coming session of Congress. One sign: Sen. Hubert Humphrey (D.-Minn.), chairman of the Senate Disarmament Subcommittee, has announced he will fight for a $400,000 appropriation for a comprehensive disarmament study under the direction of the State Department. State has indicated to Humphrey that it will support the project. Efforts by Humphrey to obtain funds for a major study this year failed, largely because the Administration failed to support the project.

National Policy Machinery

Meanwhile, a Senate subcommittee on national policy machinery headed by Sen. Henry Jackson (D.-Wash.) is studying these proposals:

- That State Department participate in the proceedings of the Joint Chiefs of Staff;
- That a JCS representative sit with the Policy Planning Staff of State Department;
- That both State Department and Defense Department participate in decisions on national budgetary "guidelines"—now decided by the Bureau of the Budget.

Jackson expects to start hearings in January.

A staff study prepared for the subcommittee took note of criticism that "our foreign policy planners, as a group, have not concerned themselves enough either with the future political consequences of weapon systems in the laboratory state, or with non-military technical developments holding promise of great impact upon foreign policy. Similarly, it is argued that our research and development programs would benefit from clearer guidelines concerning projects which might best help further our foreign policy goals."

The staff study also pointed out: "The budgetary process—the decisive resource-allocating instrument—lies at the very heart of national security planning and programing. Plans and policies, without dollar signs attached, are mere aspirations. It is the budgetary process which translates them into actual programs."

The Gold Rush

Current official U.S. concern over the foreign payments deficit and consequent drain on U.S. gold reserves was criticized last week by United Nations economists in the quarterly bulletin of the UN Economic Commission for Europe. The UN group said the "dismay and concern" shown by the United States is inconsistent with the purposes of the cause of the long-term U.S. foreign payments deficits—the foreign aid programs instituted to help European countries recover from World War II. The gold drain has been cited by the Administration as one of the reasons for holding down federal spending.

UN economists said the United States has run an international payments deficit every year since 1948, with the exception of 1957, because of the large scale assistance provided West European and other countries to promote economic recovery and growth. "It appears surprising, then, that at the moment when a considerable part of the set purpose has been achieved, not satisfaction but dismay and concern should ensue," they said.

Continental Controversy

Attempts by Continental Airlines to introduce the supersonic jet transport into the Transpacific Route Case as a significant factor in its arguments for a route from the U.S. mainland to Hawaii were checked last week during hearings in Washington. After listening to Continental officials discuss the imminence of the supersonic transport, Civil Aeronautics Board Examiner William Madden ordered all such testimony stricken from the record on grounds that it was irrelevant and that a lengthy dissertation on the subject might delay the expedited case.

However, Continental immediately injected another controversial issue which rapidly became a focal point of the arguments: a proposed three and one-half cents per mile fare on the Hawaiian route. Continental argued that this low fare is practical and feasible on turbojet transports, since its experience with the Boeing 707-120 shows that revenue plane mile costs are only $1.54 compared with $2.08 for the DC-7B. Continental became the target for more argument when it announced that the break-even load factor on its 707s is as low as 41% on a fully allocated basis. —Washington staff

Space Technology

NASA, Defense Bolster Space Structures

Air Force gains, role of ARPA diminishes in moves designed to head off demands for a single agency.

By Evert Clark

Washington—Further steps aimed at clarifying and strengthening the nation's military and civilian space programs were taken last week by Defense Department and National Aeronautics and Space Administration, at least partly in an attempt to head off growing demands for a single civil-military space agency. The changes tend to:

- **Strengthen USAF's space position** both within the Pentagon and in its relationships with NASA.
- **Simplify operation of NASA's space program** by making a more logical division between space vehicle development and operation on one hand and space payload development, data collection, etc., on the other.
- **Further diminish the role of Defense's** Advanced Research Projects Agency, particularly in the space field.

Changes announced last week include:

- **Creation of a fourth** major office in NASA headquarters, the Launch Vehicle Programs office. Director will be USAF Maj. Gen. Don R. Ostrander, formerly military director of ARPA. This office will take over responsibility for propulsion development, now under the Space Flight Development Office, and will be responsible for vehicle development and launching operations. This will put Gen. Ostrander in charge of most of the work to be done by the Army Ballistic Missile Agency development team, which is being transferred to NASA. Ostrander will chair the Saturn technical committee.
- **Change in ARPA's charter** so that it now reports to Dr. Herbert F. York, Defense's director of research and engineering, rather than to Defense Secretary Thomas S. Gates, Jr., as in the past. Army Brig. Gen. Austin W. Betts was named director of ARPA. Dr. Charles Critchfield of Convair recently was named to succeed Roy W. Johnson as ARPA head but declined because of criticism of announced plans that he would serve without government compensation in the $19,000-a-year post and continue to draw his company salary of $36,000 annually (AW Nov. 23, p. 25). Gen. Betts has been principal Army military assistant to York since last spring. Prior to that, he was deputy director of guided missiles for the Defense Department.
- **Announcement of plans** to transfer exploratory research programs that support space, such as ion propulsion, auxiliary power, etc., from ARPA to USAF.

Space Division

Richard E. Horner, associate administrator of NASA, said last week that his agency is opposed to creation of a division within NASA designed to develop space vehicles to military specifications, as the Atomic Energy Commission does in the nuclear weapons field. York also implied that this is not necessary and that the vehicle division to be headed by Gen. Ostrander essentially will be accomplishing the mission that a military division would.

Criticism of NASA's handling of booster development has been increasing within the services—primarily within the Air Force, which will operate the boosters used to launch military space payloads, but also within some top Navy circles. It includes complaints that NASA is moving too slowly on certain booster programs because it did not ask for sufficient funds and does not have enough management experience to schedule development properly and push it to completion rapidly enough.

This kind of criticism plus dissatisfaction on Capitol Hill with the general progress of the space program has led to a revival of the suggestion, first debated when the National Space Act was being drafted, that a special division be set up within NASA to deal solely with military development needs. While USAF has privately voiced considerable dissatisfaction with the pace of NASA's booster work, it is strongly opposed to this suggestion. Some Navy officials and some members of the Senate Space Committee favor the idea.

Horner's Stand

Horner said in a luncheon talk that it is "just not evident" that such a division is needed in NASA. He said use of space divides naturally into exploration, which is primarily the concern of NASA, and application of what is learned toward an end purpose. Application again subdivides into military application and civil application, and NASA "feels a continuing responsibility to support the research necessary" to help achieve military application, Horner said.

NASA, however, is considering the possible need for a biomedical division, Horner said. A survey team of biomedical specialists appointed about two months ago is due to report before the end of the year on whether the agency should continue to rely primarily on the biomedical facilities of the military services or establish its own capability.

The greater subdivision of NASA's space flight development work into the general areas of vehicle and payload will be reflected in the field as well as in establishment of Ostrander's headquarters office, Horner said.

ABMA Team

The ABMA team, which will continue to work at Huntsville, Ala., after it becomes an NASA group, will be responsible primarily for big booster work. It will retain some payload assignments, however—two new payload contracts with ABMA were signed recently—and this work will continue to

USAF Centaur Bid

Washington—Air Force would like to regain technical control of the Centaur hydrogen-powered upper stage for space vehicles because it believes National Aeronautics and Space Administration has not put enough dollars and effort behind the project to ensure early success. Centaur has a military mission to launch 24-hr. satellites that would give Strategic Air Command a global communications network. It also has civilian space missions. Project was initiated and supported by USAF and Defense's Advanced Research Projects Agency in 1958 and transferred to NASA last July 1.

Saturn Booster Review

Washington—Plan to use an Air Force Martin Titan booster as the second stage for the Saturn 1.5-million lb. thrust space booster is expected to be canceled as a result of reviews by the Saturn technical committee (AW Dec. 7, p. 34) now advising National Aeronautics and Space Administration. Committee was to meet again late last week, and a decision may be made soon on third and fourth stages for the vehicle. Selection of a second stage apparently will be postponed for a number of months.

BMD Surveys Titan Test Procedures

Washington—Team from Air Force Ballistic Missile Division is conducting a close survey of the Martin Co.'s test program for the Titan intercontinental ballistic missile in an effort to improve quality and reliability control methods and to eliminate procedural errors.

The BMD unit, which has been at the Martin-Denver plant for the past two weeks on an otherwise routine survey, is being aided by a team from Space Technology Laboratories, Inc., which is advising Martin on possible means of tightening test program procedures. STL has the responsibility for systems engineering and technical direction of the over-all Titan program.

Procedural errors reportedly have resulted in the severe damage of at least two missiles. In one instance, a Titan being transported from Denver to the USAF Missile Test Center, Cape Canaveral, Fla., in a Douglas C-133 was not properly vented, leaving it to sea-level pressure. Once airborne, the difference in the internal pressure of the missile and that of the C-133 fuselage buckled the Titan's skin.

In another, a Titan fuel tank was collapsed when a Martin technician fed liquid oxygen into the missile from a point much closer to the vehicle than authorized. When the LOX reached the fuel tank, it had not traveled through the feeder lines for a sufficient distance to reach a temperature compatible with that of the air in the tank. Consequently, the LOX chilled the air in the tank too rapidly, condensing air in the tank and causing the tank to collapse because of the much greater external pressure.

As of late last week, a Titan test vehicle had not been successfully fired from Cape Canaveral since May 4. Launch of a Titan C scheduled for early last week was postponed when the automatic checkout equipment on two occasions reported that a valve had failed to close, although a physical inspection of the missile showed that it actually had closed. It was later found that two wires in the automatic sequencer were rubbing together, causing the spurious signal to be transmitted. The launch date was then shifted to late last week.

Another C model and a B model also were on Canaveral pads, with all three vehicles scheduled to be fired this month. Another two are scheduled for January, and Air Force and Martin officials feel that, if the current series is successful, the test program may be well on its way.

Last summer, Martin recognized, as one official said, that "more stringent control was needed on the procedural side," and established an independent test operation for the Titan, removing it from the control of the Denver engineering division. The new unit is headed by George Rodney, who was brought in from Martin's Baltimore Division. Despite the problems encountered thus far, Air Research and Development Command officials said last week that there was no thought of removing the test program from Martin's direction and placing it under the direct control of BMD, STL or any other agency.

fall under Space Flight Development Director Abe Silverstein.

Jet Propulsion Laboratory, now involved in the Vega vehicle program and storable engine work as well as payload studies, will eventually be oriented more toward deep space payload work, Horner said.

NASA's Goddard Space Flight Center near Washington will concern itself chiefly with earth-centered spacecraft —satellites, manned capsules, etc. This includes the Mercury program.

In spite of the fact that acquisition of JPL and the ABMA group will temporarily increase the ratio of in-house work at NASA to 40% of the total, the agency's intention is to rely heavily upon industry, Horner said, and as the over-all program grows the percentage of in-house work will decrease.

Reshuffling inside NASA headquarters to fit the new organizational pattern will require the propulsion group under Abraham Hyatt to shift over to Ostrander's office. Another office that is almost certain to move under Ostrander is the NASA-Atlantic Missile Range operations office at the Air Force Missile Test Center, since Ostrander's group will have responsibility for launchings. The Space Flight Operations office, under Edmond C. Buckley, is considered more likely to remain where it is since its function is more in tracking and data collection.

Wallops Station in Virginia, from which Little Joe, Scout and other solid-propellant rockets are to be launched, may remain under control of Langley, Va., Research Center, which now is under the supervision of Ira H. Abbott, director for aeronautical and space research.

In addition to Ostrander, Silverstein and Abbott, the fourth major office is that of Business Administration Director Albert F. Siepert. Siepert last week named Wesley J. Hjornevik as his deputy. Hjornevik formerly was administrative assistant to NASA Administrator T. Keith Glennan. The other three directors also are expected to name deputies in the near future.

ARPA, at least for the present, continues under that name and with a separate budget that is expected to be only about $150 million for Fiscal 1961 if communication and navigation satellites can be transferred from ARPA to the services by next summer.

Transfer of this satellite work and the space-support work will leave ARPA with four programs.

- **Vega, a program of research** and development in techniques and devices for policing the nuclear test moratorium now being discussed by the U. S. and USSR. Most of this work is being done by a special Air Force unit. It includes seismological study of underground explosions and presumably includes some form of monitoring explosions outside the atmosphere such as those conducted last year in the Argus program. Atomic Energy Commission and other agencies also are involved. USAF has operated some parts of a nuclear explosion detection network since shortly after World War II.
- **New materials' research program** to be supported at a $10 million to $20 million level and done through what York called "interdisciplinary laboratories, where . . . you get physicists, chemists, electrical engineers, chemical engineers and so on all working together on problems which cross the usual boundaries of science." It will "cover things across the board pretty well, high temperature problems, metals, ceramics, thermoelectric materials and so forth," York said.
- **Defender, advanced research** related to ballistic missile defense.
- **Solid propellant** basic research.

ARPA now has only two contracts that it administers directly instead of having this done through the services. They are study contracts with Radio Corp. of America and Arthur D. Little Co. on satellite and missile defense.

Kaman H43-B Record

Bloomfield, Conn.—Kaman H43-B turbine helicopter, flown by two U. S. Air Force pilots, last week climbed to 30,100 ft. to set a new world's altitude record for its class, breaking the 29,989 ft. mark set by a Soviet Mil Mi-1 (AW Dec. 7, p. 35). Record is for helicopters in the 3,850-6,614 lb. weight class.

The H43-B, powered by a Lycoming T53 turbine engine, was flown by Capt. Walter Hodgson, of Edwards AFB, Calif., and Maj. William Davis, of Wright-Patterson AFB, Ohio. Takeoff gross weight was 5,443 lb. and the flight lasted for 1 hr. 30 min.

Mercury Network Offered for Soviet Use

By Craig Lewis

Washington—National Aeronautics and Space Administration Administrator Keith Glennan offered to let the Soviet Union use the Mercury tracking network in its man-in-space program last week, highlighting a slowly emerging trend toward limited international cooperation in space projects.

Glennan's offer came at a time when organizational disputes hampering the Committee on Space Research (COSPAR) apparently had been resolved and when the group was in the final stages of preparation for its first international space symposium next month in Nice, France.

The offer to the Russians also paralleled similar offers made to cooperate with other nations on space science projects. The U. S. is currently discussing cooperative projects with several countries, and a program with the United Kingdom is moving close to final agreement.

Glennan made the tracking offer to the Russians as evidence of U. S. interest in international cooperation. He said the Soviet Union could have tracking support from the U. S. "when and if that nation undertakes a manned space flight program." Raw tracking data would be transmitted to the Academy of Sciences in Moscow. If special recording or read-out equipment should be required, Glennan said the U. S. "would be happy to provide them or to use equipment furnished by the Soviet scientists."

Equipment Differences

Equipment differences were cited as a possible block to such a cooperative operation by Soviet scientist A. A. Blagonravov during a recent trip to the U. S., but he said it is "very desirable" to discuss such a concept. Mercury net could give the Russians much more complete tracking on a manned satellite than they can get from within the borders of Communist-controlled countries. There are no indications the Soviet Union plans to establish a tracking network outside these countries.

Russian group led by Prof. L. I. Sedov discussed possible cooperation with the U. S. last month during meetings with Glennan and with a NASA group headed by Deputy Administrator Hugh Dryden. Since the possibilities of cooperation are generally limited by what the Russians are willing to do, they were asked just what kind of cooperation they favored.

Soviet view was that cooperation would be useful but that any program should be carried out on a step-by-step basis and that the first step should be a conference on space problems as suggested by the Soviet delegate to the United Nations. Dryden told the Russians NASA would be willing to participate if invited to such a conference. UN already has an ad hoc committee on the peaceful uses of outer space which has recommended certain activities that could be undertaken within the framework of the world organization.

The concept of international cooperation was well established during the International Geophysical Year effort and, when IGY was over, COSPAR was founded under the International Council of Scientific Unions to take over and continue the cooperative effort in the space field. When the first COSPAR meeting was held a year ago, the Russians discovered they had only one seat among the 16 representatives on the committee and demanded greater representation as the price of their participation.

This politically-oriented approach to organization of a scientific group disturbed the scientists, but they set to work drawing up a compromise arrangement. Last month, Sedov said he did not know whether the Soviet Union would be represented at the Nice meeting, that he had "apprehensions" that COSPAR was bogged in discussion of organizational and constitutional questions and that he was afraid the organization would get "drowned."

At the time Sedov was making these observations here, a meeting had just been concluded in the Netherlands at which a tentative agreement was reached. This new charter opens the committee to any ICSU nation actively engaged in space research, but it also establishes a Bureau of the Executive Council in which voting power is concentrated. The executive council is composed of representatives selected from all nations on the committee, plus representatives of scientific unions interested in space research, and these latter delegates are to be chosen on the basis of broad national representation.

This new approach should provide Soviet bloc nations with greater representation. Also, all substantive decisions must be ratified by two thirds of the seven-member bureau. These seven members are to be selected for three-year terms in a ratio that will give both the East and the West a veto on decisions. This plan has been approved by ICSU and, since the Soviet Union is a member of that group, apparently the Russians have accepted the plan and will go to the Nice meeting.

Avoiding Duplication

Glennan told the Institute of World Affairs in Pasadena, Calif., last week that it is desirable to coordinate national space programs to avoid duplication and to provide the greater increase in knowledge that comes from coordinated effort. He commended the IGY space group and said "we look forward to the early establishment on a more permanent basis of the Committee on Space Research to continue coordination of basic scientific research in the space field."

Glennan mentioned satellite tracking and data acquisition, sounding rocket research, observation of the ionosphere through satellite radio signals and laboratory and theoretical research in support of space activity as examples of programs where cooperation would be most productive. "The ultimate step in international cooperation is joint participation in a single program with participation of scientists of two or more countries in the design of experiments and in the preparation of payloads for rockets, satellites and space probes," he said.

U. S. is currently discussing such cooperation with eight nations from the European and Pacific areas. These countries have made proposals, some of them in detailed form, which could form the basis of bilateral agreements for specific space science projects. This bilateral approach drew fire recently from Sen. Henry M. Jackson (D.-Wash.) who termed the approach inadequate and urged a joint North Atlantic Treaty Organization effort patterned after AGARD in the aeronautical field.

Bilateral agreement closest to realization is with the United Kingdom. Informal agreement was reached earlier this year for the British to design and build three 150-lb. satellites to be put into 300-mi. orbits with NASA's Scout booster by mid-1961. This agreement is expected to be made formal when

Mauler Team Selected

Washington—Army competition to select a contractor to develop the Mauler air defense missile system for field use has been won by Convair-Pomona and Raytheon which bid as a team. Other bidders included General Electric, Martin and Sperry Rand.

The program has been under a cloud of uncertainty as to whether the Army would have sufficient funds since bids were first submitted almost a year ago. All proposal prices were considerably higher than original Army estimates of what the program would cost.

USAF to Test Air-Launched Sounding Rocket

Test program to determine feasibility of vertical air-launched sounding rockets to measure natural radiation surrounding the earth is being conducted by Air Research and Development Command's Special Weapons Center. Three-stage solid propellant rockets, designated Jaguar, are designed to reach altitudes of up to 600 stat. mi. after launch from a Martin B-57.

British scientific group visits the U. S. in the near future. Another proposal under discussion involves a Canadian plan to orbit a "topside sounder" satellite which would bounce radio signals off the ionosphere from above for comparison with ground signals reflected from the bottom of the ionosphere.

These satellites would be launched by U. S. boosters—probably the solid-propellant Scout which is estimated to cost about $600,000 each. Even with this inexpensive vehicle, a satellite project may cost as much as $10 million when the expensive data gathering and analysis is included. Along with complete satellites, other nations are proposing individual experiments which would ride along with planned U. S. satellites.

Basic advantage to other nations in this cooperative approach is that the U. S. can provide the boosters they don't have. Arnold W. Frutkin, NASA director of international programs, points out that the U. S. benefits in turn by getting data from satellites NASA would want to put up itself if other nations weren't doing the job under the cooperative programs. All projects are mutually agreed upon before they are launched. No funds are exchanged; the U. S. pays for the launching vehicle and the cooperating country pays for the satellite. Scientists from these nations also are invited to work on their projects in U. S. laboratories if they wish.

Pattern for another phase of cooperation was set this month when NASA released a detailed report on the Project Echo inflatable sphere which will be launched next spring as a passive communications satellite (see p. 65).

A third form of cooperation involves the worldwide tracking and telemetry facilities involved in such projects as the Mercury network. NASA pays organizations such as the University of Manchester, which runs the Jodrell Bank facility in England, and other groups for tracking and for telemetry data gathered. A number of tracking stations have been established by the U. S. in other countries which are run by personnel from those countries.

Blue Water Missile Backed As NATO Arm

Bonn—Defense ministers of Great Britain and West Germany will recommend adoption of Britain's Blue Water tactical ballistic missile as standard North Atlantic Treaty Organization equipment.

Blue Water is under development by English Electric Co., Ltd., as a replacement to the U. S. Corporal mobile tactical short range missile used by the British army. Blue Water's range is 80-100 mi. and the missile probably will utilize solid propellant fuel.

Harold Watkinson and Franz Josef Strauss announced the joint decision following two days of meetings in Bonn. They added that if NATO agreed, the two countries would jointly develop the 100-mi. range missile. The weapon will be capable of carrying a nuclear or conventional warhead, is intended to have a high degree of accuracy, and would actually be ready in about 1964.

Bonn observers point out that such a weapon would dovetail with proposals by the Western European Union (WEU) for an independent nuclear strike force. Britain and Germany along with France, Italy, Belgium, Holland and Luxembourg are members.

However, the British are the only ones who currently possess a nuclear capability, and have officially expressed reluctance to share it with non-nuclear powers.

Strauss and Watkinson also agreed on cooperation in aircraft engine development. Of prime importance in this respect are working arrangements between Rolls-Royce and Maschinenfabrik Augsburg-Nurnberg and between Bristol Siddeley Engines, Ltd., and Kloeckner-Humboldt Deutz AG. Cooperation in anti-aircraft defense against low-flying aircraft was also cited.

Rocketdyne Flow Pump

Los Angeles—Axial flow pump for liquid hydrogen is being operated by Rocketdyne Division of North American Aviation, Inc., as part of a joint Atomic Energy Commission-National Aeronautics and Space Administration rocket research program.

Under a company-sponsored research program, Rocketdyne also has operated hydrogen-oxygen rocket engine components consisting of a thrust chamber and a complete liquid hydrogen feed system, including a LOX-hydrogen gas generator and turbine and controls.

MONKEY is held in its plastic foam couch (left) by a harness which leaves its arms free to perform tests with a lever. Monkey was carried in a biopack (right) which was positioned so the animal took acceleration forces transversely during the Little Joe tests.

Little Joe Launch Tests Mercury Capsule

NAVY RECOVERY team opens the pressure vessel in the boilerplate Mercury capsule (left) and removes the biopack containing the monkey (right). The 100 lb. biopack had a plastic shell and aluminum inner structure, and the system carried a 40 hr. supply of oxygen.

BOILERPLATE Mercury capsule was launched (left) by a Little Joe booster with four Castor and four Recruit solid propellant rockets. Capsule landed in the Atlantic Ocean after its 13 min. flight and was picked up less than two hours after launch (right).

Escape

Washington—Third Little Joe shot by National Aeronautics and Space Administration tested escape rocket blast effects on the Mercury capsule fuselage and carried a monkey safely through the escape and recovery cycle.

Primary aim of the Little Joe launch from Wallops Station, Va., was a high altitude test of the escape rocket system and measurement of the pressure and temperature effects on the Mercury capsule fuselage. The flight also carried a monkey through the escape cycle under the maximum acceleration expected during an emergency escape on an actual Mercury launch with a man aboard.

Boilerplate Capsule

This test with a boilerplate capsule was the third in a series of Little Joe launches of experimental capsule hardware. The series is scheduled to include a qualification test of the McDonnell Aircraft Corp. capsule now in production. Series thus far has included tests of the booster system and of the escape system under maximum dynamic forces.

Third launch was the first in which the Little Joe booster, built by North American Aviation, Inc., used all four Thiokol Castor and four Thiokol Re-

MONKEY was removed from biopack by crew of USS Borie nearly seven hours after launch and showed no ill effects from the forces and weightlessness encountered.

cruit solid propellant engines. Castor develops about 55,000 lb. thrust and Recruit about 35,000 lb. In this launch, two Castors and four Recruits fired together, providing 250,000 lb. thrust at liftoff. Recruits burn 1.5 sec. and Castors burn about 25 sec. Second two Castors were ignited after 20 sec. of flight.

Capsule had a pressure vessel about three feet deep immediately behind its blunt face, and this compartment carried instrumentation, a biopack containing the monkey and several other biological experiments. Remainder of the capsule was a shell simulating the conical fuselage and the cylinder at its top. The interior of the fuselage was instrumented at several points to measure temperature and pressure effects of the escape rocket exhaust stream.

The boilerplate capsule returned to earth at a relatively low speed, making a heat shield unnecessary. It had a non-ablative blunt face made of glass fiber and Hetron 72 resin binder.

During the flight, the Grand Central escape rocket was fired when the booster and capsule reached 100,000 ft. The rocket is six feet long and 18 in. in diameter and develops about 55,000 lb. thrust. Escape rocket burned 0.6 sec. and carried the capsule away from the booster at the rate of 220 fps. Peak acceleration of about 19g and peak velocity of about 5,100 fps. were reached at escape rocket burnout. The escape rocket tower was jettisoned at 150,000 ft.

Capsule coasted to an altitude of about 55 mi., considerably short of the 75 mi. peak expected. Since the scheduled altitude was not reached, the monkey did not experience the full four minutes of weightlessness expected. After it reached 55 mi., the capsule completed its 13 min. trip with a landing in the Atlantic Ocean about 200 mi. from the launch point.

During the final segment of the capsule's flight, NASA departed from reentry procedure scheduled for the Mercury capsule and allowed the boilerplate model to fall to 20,000 ft. before the drogue parachute was deployed. Normal practice is to deploy the drogue chute at 70,000 ft. to provide stability, but NASA allowed the capsule to drop to 20,000 ft. to test the aerodynamic stability of the capsule shape in the atmosphere at subsonic speeds. Main chute was deployed at 10,000 ft.

Capsule was equipped with the Sofar bomb, dye marker and radio beacons from the Mercury recovery system, and first contact was made when a patrolling Navy Lockheed P2V sighted the green dye marker 39 min. after launch. Destroyer USS Borie was 15 mi. away, and reached the inherently buoyant capsule and had it on board within two hours of launch, despite waves 8-10 ft. high.

Heavy seas kept the recovery force from making a planned transfer of the biopack containing the monkey to the Landing Ship Dock Ft. Mandan. This ship carried the only doctor in the recovery force, and he was to monitor the monkey with the same type of plug-in equipment used during countdown. Then he was to have carried out the delicate job of removing the monkey from the biopack.

After prolonged attempts to transfer the biopack, the plan was abandoned, and destroyer personnel removed the monkey under radio instruction from the Ft. Mandan. The monkey was alive and apparently suffered no ill effects from the trip.

Data on booster and tower separation were telemetered, but the bulk of the test data, including all the biological information, was transmitted to recorders in the capsule. Therefore, the condition of the monkey could not be determined until the biopack was opened nearly seven hours after launch. The monkey was in the capsule 15 hr. and 45 min. during the countdown plus nearly seven hours after the launch.

Monkey was flown to the Air Force School of Aviation Medicine at Brooks AFB, Tex., for examination and study. Data from the recorders is being examined to determine detailed results of both the capsule and biological tests.

Animal used in the Little Joe test is a Texas-born male rhesus monkey named Sam from the initials of the School of Aviation Medicine. He was 30 months old and weighed seven pounds at the time of the test. Monkey had been trained at the USAF school to perform a lever operation, and the number and frequency of responses to a light will provide a measurement of performance ability under the launch and escape maneuver conditions encountered.

Along with the psychomotor test, scientists took three physiological measurements on the monkey during the flight. An oculormotor measured disorientation and dizziness through electrical impulses from the eye muscles. Heart activity was measured by an electrocardiogram vectorcardiogram, and respiratory movement was recorded by a helio potentiometer.

Biopack containing the monkey was one of a number of biological space containers developed by the School of Aviation Medicine (AW Feb. 16, p. 34). The 100 lb. container is three feet long, 16 in. in diameter, and it has a plastic shell and annealed aluminum alloy structure. Shell can withstand a positive pressure of 25 lb. and negative pressure greater than that created by a vacuum.

Oxygen was supplied to the monkey from a tank through a two-stage reducer regulator. Temperature in the biopack was regulated by filtering body heat into a heat sink. A small fan circulated air, and absorbents were used to remove excess moisture and carbon dioxide. The biopack had enough oxygen to last 40 hr., and the capsule had a snorkle system which could have provided air for breathing if the oxygen ran out.

Monkey rode in a plastic couch lined with a shock absorbent plastic foam and tailored to the animal's shape. It was covered in front with a restraining harness. The couch held the monkey so that it faced skyward during launch and descent and absorbed g forces transversely, as will the Mercury pilot.

Biopack had three additional biological experiments attached to its outer wall. One consisted of emulsion track plates of barley, rat nerve cells and neurospora to measure primary radiation effects. Bacteria cultures were included to study lethality and mutation rate, and cell tissue cultures will be studied for changes in appearance and reproductive capacity. The third experiment involved flour beetle larvae for study of changes in appearance, mutation rate.

F4H Altitude Record

Edwards AFB, Calif.—New world altitude record of 98,560 ft. has been set by a U. S. Navy McDonnell F4H Phantom II. Piloted by Cmdr. L. E. Flint, USN, the F4H, powered by General Electric J79 engines, bettered the Soviet record of 94,658 ft. set last July (AW Aug. 3, p. 32).

Still to be confirmed officially by the Federation Aeronautique Internationale, the F4H exceeded the mark set by the USSR by 3,902 ft., or a little more than 1,000 ft. in excess of the required 3%.

Record flight, made Dec. 6, was performed with the aircraft carrying its standard armament of Sparrow III missiles. Maximum speed attained by Flint in his flight was 1,550 mph., or Mach 2.34. Temperature at the acceleration altitude of 47,500 ft. was —67C.

Flint began his pull-up from 47,500 ft. when the airspeed had stabilized at its maximum. Fuel on board was 3,300 lb. at end of the maximum speed. Power was kept at maximum until such time as the scheduling of the fuel controls could not prevent overspeeding the engines, and then both engines were stopcocked. The aircraft then expended energy for altitude until the maximum of 98,560 ft. was reached.

Cockpit pressurization, which normally depends on bleed air from the engine compressors, was supplemented by nitrogen under 2,500 psi. Nitrogen pressure within the cockpit was maintained at about 45,000 ft. equivalent altitude as an added safety feature, although Flint wore an inflated pressure suit.

Congress Plans Space Program Probes

By Ford Eastman

Washington—With an eye on next year's election campaign, Congress plans to probe all aspects of the national space program during the coming session to expose the roots of its problems and to determine if any effort is being made to give it new life.

Major thrust of the attack will be directed at the National Aeronautics and Space Administration and the National Space Council, which is headed by the President and largely composed of cabinet officers and administrators of government agencies. But it will also include a searching review of the military space program and its relationship to the civilian program.

Atmosphere for the investigations was set by the spectacular Russian achievements in space exploration which were followed in several instances by spectacular U. S. failures, and by the apparently widening gap between Soviet and U. S. space achievements. This gap will be examined in the context of an election year.

Any new Soviet space achievement in the next few months could easily make the U. S. space program one of the major campaign issues. Absence of further Russian success, however, might tend to downgrade its importance somewhat as public interest wanes, unless Congress revives this interest through its investigations.

First investigation of the space program has been scheduled for Jan. 6, the day Congress reconvenes, by Rep. Overton Brooks (D.-La.) chairman of the House Committee on Science and Astronautics. Hearings will run for a full month, and a complete investigation of all aspects of both the civilian and military space programs is planned.

The Senate Committee on Aeronautical and Space Sciences, headed by Sen. Lyndon B. Johnson (D.-Tex.) has not scheduled hearings or announced a course of action, but it is expected also to hold hearings early and dig deep into the controversial aspects of the program.

These probes will be followed by hearings on authorization for appropriations in both Houses and by the appropriation hearings themselves, all of which will be sweeping reviews of policies, funding of projects and administration of programs.

In addition, there are strong indications that there will be full-scale probes into select areas of the space program by various subcommittees.

One investigation of this type is under consideration by the House Military Operations Subcommittee headed by Rep. Chet Holifield (D.-Calif.). Holifield already has hinted his subcommittee might look into the transfer of the Army Ballistic Missile Agency to NASA, and it may go further than that and investigate the over-all military role in space and its relationship to the civilian space agency. The emphasis would be not so much on technical aspects as on the level of effort and funding needed to fully develop defense potential in space.

In the over-all probes, here are some of the key questions to which both the House and Senate space committees will be seeking answers:

- **Does the United States** have a national space program that is designed to eventually give it leadership in space exploration?
- **How much importance** and urgency does the Administration attach to a national space program?
- **Are sufficient funds** being requested by NASA to carry a broad and vigorous program forward in orderly fashion, or are delays and cancellations encountered due to budget limitations?
- **Are vital military projects** being transferred to NASA for development because of defense budget restrictions?
- **Should military and civilian** space efforts be merged in a single agency similar to the Atomic Energy Commission with a military applications division?
- **How long would it take** and how much money would it require to catch up to and surpass Russia in space exploration?
- **Is there a lack of firm** direction and coordination in the space program, especially at the top policy-making level?
- **Why hasn't the Administration** appointed a full-time staff for the National Space Council as provided for in the National Aeronautics and Space Act of 1958, and what effect does this omission have on the United States' failure to close the gap with Russia?
- **Is progress in the space** effort retarded by too many policy or advisory committees, unwieldy organizations or other red tape?
- **Is money appropriated** for civilian and military space efforts being wasted through unnecessary duplication of effort, rivalry or poor administration?

Of all the questions which will be raised by Congress during the coming session, the amount of money which will be requested for the space program for Fiscal 1961 will probably be the biggest issue. Various members of Congress have accused NASA of underestimating its budget requests for the current year and point to the approximately $45 million reprogramed from lower priority projects to top priority projects.

On the other hand NASA's Fiscal 1960 budget, which NASA said was tight but would provide all the money that could be used wisely in pursuing a vigorous program, was cut $30 million by congressional action. Similar action during the next session by a Democratic-controlled Congress would greatly reduce Democratic chances of making money an issue. Also, if the Administration decides to ask for a budget of around a billion dollars plus a sizable supplemental request (AW Dec. 7, p. 32), additional steam will have been taken from the issue.

While the hearings are likely to produce considerable fuel for political debates, there is not much chance that any major changes will be made in the Space Act during the coming session. Congress will be hard-pressed for time, since it faces many other problems and hopes to adjourn before the national party conventions in July.

National Space Effort Opposed in Britain

Britain should reject as "grossest folly" any attempt to establish a national space program, according to recommendations made by the Government Advisory Council on Scientific Policy. The committee said Britain cannot afford more than a half-million dollar expenditure in this field annually.

British critics point out that this is less than half the government subsidy awarded the Covent Garden Opera Company and doesn't even match the $138-million subsidy doled out to farmers for chicken food or the $2½-million paid by the taxpayer to advertise the government's egg-selling campaign.

The committee, which is charged with the responsibility of advising Britain's new science minister, Lord Hailsham, on all matters concerned with scientific research and development, has 15 scientific members but excludes space and rocket experts.

This latest British appraisal of space research is not far out of line with the poverty of British research expenditure generally. The government awards only $27 million annually to industrial research, $10-million to medical research and $100 million to universities. Yet the nation spends $1,000 million on advertising, $1,570 million of its nationalized health program, $6,000 million on alcoholic drinks and cigarettes.

In its report the advisory committee called for the establishment of an international effort to which Britain and other countries could contribute.

Army Plans to Set New Policies For Developing, Buying Aircraft

By J. S. Butz, Jr.

Washington—U. S. Army aviation research, development and procurement policy for the next five years at least is scheduled to be firmly set by Mar. 15 in one of these directions:

- **Development of a completely new** group of aircraft after a design competition or source selection action.
- **Steady improvement of aircraft** now in service or under development.
- **Increased research effort** to quickly bring promising ideas to a usable state.
- **Flight competitions** of finished aircraft to decide which to produce.

One of these policies will be followed for the development and procurement of future equipment for each of the Army's three major aircraft missions—close observation of the battle area, surveillance of the enemy's rear and forward area air transportation of troops.

Industry Conference

Army is calling upon industry to give a major assist in determining just what the policy will be for each type of aircraft. Industry was asked in a recent requirements conference at Ft. Monroe, Va., to submit a summary of the kinds of aircraft that could be built during the next five years to fulfill the three basic missions most efficiently and economically. This was a basic departure from the prior Army method of asking for aircraft with specific performance in payload, speed, range, etc.

Over 130 aviation and avionic firms sent more than 400 representatives to the conference, where they were asked to inform the Army by Dec. 15 if their companies would submit studies recommending the best course for Army aviation during the next five-year period. If the company plans to participate, its studies must be submitted by Feb. 1. Primary reason for the request is an Army desire to obtain a cross-section of industry thinking on state-of-the-art studies made in the past year or so without going into a protracted period of further studies.

In turn, the Army hopes to move rapidly and plans to reach a policy decision by Mar. 15. This policy decision involves Fiscal 1961 funds, and the plan that is formulated will be put into effect July 1. A fund of from $6 million to $14 million will be kept open in the Fiscal 1961 Army budget to implement the first year of this new program.

In making the decision to keep funds available for unspecified expenditures until the middle of March, the Army conferred with the cognizant administration and budget authorities above it in the Department of Defense. The philosophy of the program was explained to Defense Department officials, along with the estimated funding that will be required in the future. This estimate runs from $100 million to $150 million in research and development and test and evaluation money each year beginning in Fiscal 1962.

In the past, Army research and development funds for new aircraft have been much smaller than this, but, under the old Army bookkeeping system, all development work past the mockup stage was financed from procurement funds. The new system specifies that research and evaluation funds will be used through acceptance tests.

The funding level for aircraft development has run from $100 million to $150 million during the past four years, and the new accounting method will not alter this appreciably in the future. The actual level will depend primarily upon the basic policy decision on Mar. 15 as to whether the Army will build a new family of aircraft.

The general requirements for observation, surveillance and transport aircraft that the Army presented to industry stressed several points. Easy maintenance is probably the primary one. The Army wants all maintenance operations, except major overhaul, performed within a very short time period and capable of being conducted out-of-doors in all types of weather. Fuel economy is another point. Both of these requirements are considered necessary if the Army is to be able to disperse properly when it is facing modern high-yield weapons on the battlefield.

Dispersal in itself is believed inadequate if small troop units cannot take reliable, economical aircraft with them so that they can concentrate rapidly, go into action briefly and then disperse again. These overriding requirements for aircraft use were presented to industry against a background of an enemy air defense which is greatly improved over World War II and Korea. Such defenses, when combined with dispersal tactics, presumably will make high flight speeds and short landing and takeoff capabilities an absolute necessity.

Space Technology

Thor-Able IV Will Test Telemetry From 50 Million Mi. in Space

Washington—First U. S. attempt to place a satellite into an orbit that will carry it back and forth between the orbital paths of earth and Venus is scheduled to be made this week.

The 90-lb. paddlewheel satellite (AW Dec. 7, p. 33) is expected to test radio transmission from its payload to earth over distances of 50 million mi. or greater and to help determine the size of the astronomical unit, the basic unit of measure for astronomical distances.

The probe is designated Thor-Able IV and originally was planned as a probe that would be fired last June in an attempt to pass very near the planet Venus. It was to have been fired within a few days of the Atlas-Able IV, whose original mission also was to go to the vicinity of Venus.

The Thor-Able IV payload is a roughly-spherical aluminum body with a diameter of 26 in. Two ultra high frequency antennas protrude from the top and bottom. It carries instrumentation for measuring solar and cosmic radiation and its interaction with magnetic fields, a digital telemetry unit, telemetering transmitter operating on 378.21 mc. at varying power levels, doppler system transponder, a doppler receiver and command system and power converter.

Since it is a National Aeronautics and Space Administration experiment being conducted by the Air Force Ballistic Missile Division and Space Technology Laboratories, Inc., its design and instrumentation are quite similar to the BMD-STL payloads used in the first Pioneer lunar probes, the Explorer VI satellite (AW Aug. 17, p. 30), and the unsuccessful Atlas-Able IV probe (AW Dec. 7, p. 31), which had its mission diverted to that of a lunar orbiter because it was not ready for launching at the time when Venus and earth were in a favorable position roughly opposite one another.

The telemetry transmitter will operate at a low power level of less than 10 watts during the first few days of flight, while it still is close enough to earth for that power level to make its signals detectable at several tracking stations.

The probe is expected to move into an orbit around the sun, with its aphelion approximately 93 million mi. from the sun and in the path of the earth's orbit, and its perihelion about 61 million mi. from the sun in the

vicinity of Venus' orbital path. Period is expected to be somewhat slightly over 290 days.

The maximum possible distance between the earth and the probe could be as high as 186 million mi. if they are on opposite sides of the earth's orbital path at the same time.

Because of the great distances involved late in the flight, transmission will be intermittent—probably in bursts of about 5 min. each. As the probe moves farther from earth, power level will be 150 watts, and only the University of Manchester's 250-ft. radio telescope at Jodrell Bank in England will be able to receive the signals.

In addition to determining whether scientific information can be transmitted successfully over interplanetary distances with present equipment, the probe could help considerably in refining the measure of all astronomical distances.

By obtaining range and velocity from a number of points in the probe's flight, scientists may be able to compute more accurately the mean distance from earth to sun.

Heat balance within the payload will be maintained by a paint pattern. Temperature rise as the probe nears the vicinity of Venus will be quite high. The paint pattern can be altered by use of decals if launch is delayed past the first day.

Four solar paddles covered with a total of 4,800 cells will collect solar energy to be converted and stored to power the transmitter. Power output of the four paddles will range from approximately 13 to 25 watts, depending upon the probe's orientation to the sun.

News Digest

Lockheed Aircraft Corp. will form a new subsidiary, the Lockheed Electronics Co., in a move aimed toward increasing its share of the government and industrial electronics market. New company, which will include recently acquired Stavid Engineering and the newly formed Lockheed Electronics and Avionics Division (LEAD), will be headed by David F. Sanders, former Stavid president. M. Carl Haddon, Lockheed vice president and general manager of LEAD, will hold a similar position in the new company, heading its Newport Division, the new name for LEAD. Frank J. Reynolds, Stavid executive vice president, becomes a vice president of new company and general manager of the Stavid Division.

Boeing Airplane Co. is flying the B-52G bomber at a maximum gross weight of 488,000 lb., 40,000 lb. above the prescribed Air Force limit for the aircraft, as part of the plane's structural flight test program. Boeing says that, if USAF decides to boost the maximum gross weight for operational B-52Gs, the additional 40,000 lb. could be used for fuel to increase the bomber's range or for additional weapon stores.

Fairey Aviation Co. has rejected government terms to develop the Fairey Rotodyne VTOL (AW July 27, p. 33), Aviation Minister Duncan Sandys has told the House of Commons. Terms included the government's intention to reimburse subsequent development costs if a specific minimum order did not materialize.

Hawker Siddeley P.1127 VTOL close support jet fighter (AW Dec. 29, 1958, p. 27) will make its first flight within the next six months. Powerplant will be a Bristol Siddeley BE. 53 turbojet engine of 14,000 lb. thrust (AW June 22, p. 78). Sources indicate the plane has a delta configuration with transonic speed capability.

Aerojet-General Corp. has developed a liquid rocket engine, the XLR-113-AJ-1, with variable thrust range of from 59,000 to 150,000 lb. Engine, developed under Air Force contract, is lightweight and operates with storable propellants and has a film-cooled thrust chamber. Proposed use of the engine is to propel rocket sleds for testing of missile components under simulated flight conditions.

USAF-Convair Atlas successfully fired over Atlantic Missile Range last week was the 12th successful missile shot in a row. Of 39 Atlases fired thus far, 24 have satisfied all test objectives and the remaining 15 have satisfied over half of the major objectives. The 39 have included the orbiting Atlas in Project Score; a booster for the Mercury capsule and the booster for the Atlas-Able lunar orbiter.

First design details of the Bristol T.188 Mach 2.5 stainless steel research aircraft (AW Oct. 27, 1958, p. 34) show use of engine nacelles nearly 30 ft. long, widely spaced on wings to provide drag-reducing shock wave integrations between the fuselage and nacelles. Powerplants are modified Gyron, Jr., turbojet engines in 10,000-lb. thrust class (AW Sept. 14, p. 68). Fuselage is 71 ft. long. Wing is in mid-fuselage and has 36 ft. 1 in. span, with 4% thickness chord ratio. Mid-section sweep is 38 deg., increasing to 64 deg. over the all-moving tip sections forming the ailerons.

Midair collision of two Beech planes at the Palm Springs, Calif., showing of the 1960 Beechcraft line caused loss of five lives. Planes, a TravelAir and Bonanza, were on demonstration flights for customers of Norman Larson Co., Van Nuys distributor.

Freon-14, or tetrafluoromethane, a refrigerating compound that boils at −198F, now is being used as the propellant for the small control rockets in the final stage of the Discoverer satellite vehicle, according to E. I. du Pont de Nemours & Co. The propellant supply forms an integral part of the vehicle's 70-lb. pneumatic attitude control system which goes into operation after burn-out and separation of the Thor booster.

Vertol Aircraft Corp.'s YHC-1A and V-107 prototypes flew to Ottawa last week for demonstrations to military services, airlines and helicopter operators in the Ottawa and Montreal areas. Royal Canadian Air Force has ordered two additional V-44s for delivery in March, 1960; RCAF currently has three V-44s and 15 H-21s.

Chance Vought Aircraft, in what probably is the most ambitious extension it has made into commercial markets as part of its diversification program (AW Oct. 26, p. 125), now has become a major factor in the trailer homes industry. Company has acquired two mobile home firms—General Coach Works and ABC Coach Co.—and has signed a purchase agreement with Mid States Corp., of Battle Creek, Mich.

National Aeronautics and Space Administration awarded $1.67 million in contracts during October, including an initial $250,000 contract to Ball Brothers Research Corp. for instrumentation for an earth-orbiting solar observatory to be launched with a Delta rocket. Total funding for this contract may reach $750,000. Contracts also included $150,000 initial funding to Army Ordnance Missile Command for design, construction and integration of a satellite to be launched by a Juno II to study energy and source of cosmic rays; $150,000 to the same agency for an ionosphere-sampling satellite; $360,000 to Navy Bureau of Ordnance for 19 solid rockets to be used in Air Force's Project 609A, which is a modified NASA Scout, for high-altitude and reentry tests; $70,000 to Massachusetts Institute of Technology for basic research on noise phenomena associated with rockets and jet aircraft.

Incentive Plans Promote Airline Travel

Travel plans gain potential as business firms promote mass personnel airlifts as important sales tool.

By Glenn Garrison

New York—Airlines are reaping increasing benefits from the expanding use by business firms of travel incentive plans involving air transportation, a growing segment of the group travel market that will be an important factor in filling airliner seats.

Incentive travel plans, often tied in with company sales meetings with extensive use of airlift, are developing into an important business tool not only for large firms but increasingly for smaller companies. In fact the smaller groups, which travel on scheduled flights and provide airlines with a flexible way to top off loads, are considered by many carriers to be a big potential in this field.

Large firms, however, have provided some recent spectacular examples of the use of chartered airliners to bring their dealers or salesmen from all over the country to a central point for business and/or pleasure. A giant operation now under way at Miami by the J. I. Case Co. involves 157 flights by seven airlines and is expected to total 25 million passenger miles of travel.

Package Costs

Case's movement of more than 7,000 dealers and distributors of its farm implements and industrial machinery began Dec. 4 and the return flights will end Jan. 11. Case won't disclose the total cost, but an airline official has estimated that the company will pay about $1 million for the whole package, including hotel accommodations and local entertainment. Dealers are coming in from 62 cities in the U. S. and Canada and one plane load is arriving from Paris.

Cole H. Morrow, executive assistant to the president of Case and coordinator of the Miami operation, told AVIATION WEEK that his company's sales have increased 300% during the three years since the airlift program was initiated. Case held its "World Premiere" program in Phoenix, Ariz., in 1957 and in Nassau in 1958. The Phoenix meeting involved 12¼ million passenger miles and the Nassau meeting 19 million.

These annual meetings, where the year's line of products is unveiled and merchandizing plans presented, have proved "very successful," Morrow said. They are "the most important thing we do in the company for a year," he added. Morrow stressed that the session is a business meeting, "not a holiday," although sales incentive features are involved in the meeting program.

Dealers meeting the required sales quotas, for example, can bring along their wives, expense-free. But all dealers, regardless of their quota status, attend the meeting.

This differs from some other plans which are designed only to provide expense-free vacations or trips for dealers or salesmen who meet certain quota requirements.

Case follows up its yearly meetings with the distribution of films and other promotional material based on the "World Premiere" program. The meetings themselves, Morrow pointed out, could not be accomplished except through the use of air transportation. "The airplane is being used as a tool for a definite type of business operation," he said.

The Case air operation at Miami is centered at Eastern Air Lines' old 36th St. terminal at Miami International Airport, across the field from the new terminal which handles regular scheduled traffic. Eastern is handling about a fifth of the airlift, some 33 charters in 90-passenger Douglas DC-7B coach aircraft. The Eastern terminal was reactivated for the project.

Case is actually running the show from an operational standpoint and has set up a center in the terminal complete with teletype to every airline operations office and to Case branch distributor offices in 28 U. S. and Canadian cities. In all, 40 Case employes are in Miami to handle reservations, local transportation, and other phases of the operation.

On-Line Point

Of Eastern's flights, 11 will involve off-line points such as Kansas City and Toronto and the rest will originate or terminate at on-line points in its system. Other airlines involved are Delta, National, Northwest, Pan American, Scandinavian Airlines System, and United. Equipment for use in the program was flown in by United cargo aircraft and United will handle about half of the passenger charters. SAS supplied transportation for the Paris contingent. Airline equipment chartered for the program includes Douglas DC-6Bs and DC-7s, Lockheed Super Constellations and Boeing Stratocruisers. Case insisted that all bids should offer radar-equipped airplanes, according to Eastern.

The special projects department of Case began its first studies for this year's meeting last July, Morrow said, and first contracts were let around Oct. 1. Contracts were let on a flight-by-flight basis.

Airlift Timing

The mass movement is being timed to avoid conflict with the Christmas and New Year's holidays when airline equipment will be in short supply. It does, however, come uncomfortably close to the extreme holiday peaks. Under the plan, groups of dealers are flown in, spend five days and four nights, and are flown out again to be replaced by other groups.

On the first day, Dec. 4, some 34 flights arrived; another movement took place Dec. 8, bringing in additional groups and flying out the first arrivals. These staggered movements will halt Dec. 20 and resume Jan. 3 to skip the two holidays. During the movement days, a plane is scheduled to arrive or depart every 15 min. First day's arrivals came from such scattered points as

Atlantic Charters

New York—Charter passengers handled by scheduled airlines on the North Atlantic more than doubled during the first nine months of 1959 over the same period of 1958. Total for the first three quarters of this year was 163,722 passengers carried in International Air Transport Assn. member aircraft.

This 1959 nine-month total was 110% higher than last year's for the same period. Among the reasons: plentitude of piston equipment for charters as most carriers waited for jets (AW Dec. 7, p. 36), and a fast-growing, competitive market for this lower-cost traffic both for scheduled and non-scheduled carriers (AW June 2, 1958, p. 28).

San Francisco and Los Angeles, Phoenix, Houston, Atlanta, and Oklahoma City, among others.

Case describes its operation as "the largest civilian airlift in history." Other examples of recent large movements of business sales groups are those of Gibson Refrigerator Co., which offers yearly free vacations to dealers who satisfy quota requirements. The 1959 incentive operation by Gibson involved movement of more than 3,000 persons to and from San Juan, Puerto Rico, with several airlines participating with charter aircraft and scheduled space.

Another example is Fedders-Quigan Co. (air conditioners), which has given its dealers vacations in Jamaica, Mexico and Europe. Largest group was 3,000 persons. The 1959 travel was divided between Acapulco and Europe, with Pan American handling the transatlantic business involving 2,000 dealers (AW June 2, 1958) and Eastern, among others, bringing the vacationers to the New York gateway.

Gibson is planning a chartered jet airlift next year to Honolulu, with Pan American handling the entire 31 flights from 15 U. S. cities in Boeing 707-320 equipment.

Like the firms which are going in for incentive travel to boost their sales, organizations of various kinds are ranging farther afield to hold their annual conventions. Convention business has long been a big source of airline revenues, of course, and many carriers have special departments to handle it. Growing use of air transportation in convention activities has changed the geography of convention sites and the jets with their telescoping effect on time and distance will greatly expand this trend.

Examples of this trend are the convention of the World Baptist Alliance, scheduled for Rio de Janeiro next year, and a Rotary International convention planned in Tokyo in 1961. The Baptists are expected to number about 4,000 and will be moved by various airlines on a common carriage basis mostly in tourist accommodations. Planning for this operation was begun a year and a half ago by a Birmingham, Ala., travel agent who called the airlines together to work out the airlift part of it. "Anything that's got wings on it will be used," according to one airline official.

Firms offering travel incentive plans in some cases are competing with each other to stimulate dealer efforts, and this is a happy situation for the airlines. If a dealer handles, for example, television sets of several manufacturers, he might find himself in the pleasant position of choosing which vacation spot he would like to visit free. If Brand X promises him Hawaii for pushing its line and Brand Y offers Bermuda, he could concentrate on the spot of his choice. In some cases, he might sell enough of different lines to get two incentive trips, or even more. One airline official says he has seen the same distributor show up at several vacation spots during the year, each time enjoying the rewards of an incentive plan. The airlines, naturally, would not be discomforted if he won 20 trips.

More and more small companies, airline officials say, are turning to travel incentive plans to boost business. Other incentive rewards—cash or "pots and pans" (merchandise selected through a catalogue)—don't produce the same results, in the airline view. A vacation trip is more likely to be remembered and the winner often meets and gets to know company executives.

Most of the incentive plans are designed to stimulate sales representatives but there are exceptions. For example, American handled a group of taxicab drivers who had participated successfully in their company's safe driving campaign. The groups can be small: National this month is flying to Miami 15 winners of a dry cleaning competition. In some cases of large firms, company policy prohibits putting more than a certain number of their representatives on a single flight. Another National incentive group movement involves 170 winners of a can company reward, and the airline can carry only 10 on any one airplane.

Incentive travel, though important and growing, is of course only a facet of the over-all market for group travel. This includes, to most airlines, any group of passengers from about a dozen up to a chartered planeload and is variously handled in sales approach and statistical analysis. This market has been growing rapidly in the past five years or so and provides many advantages for the airlines.

One of them, as pointed out by Philip M. Siefert, Pan American's manager of special sales—as well as other airline officials—is the leveling of off-season traffic valleys. Another indirect reward comes from providing many group customers with air travel experience which leads to future sales.

Fifth Airport

New York—Port of New York Authority will meet today with New York and New Jersey legislators to discuss plans for a fifth metropolitan airport in this area under Port Authority operation. The agency reportedly has plans for a major commercial airport near Morristown, N. J.

Governor Robert Meyner of New Jersey and some local officials have voiced objections based on the charge of the "poor aircraft noise record" at New York International Airport.

According to Siefert, Pan American's group travel revenue for this year will total about $8 million, and the incentive travel portion of the total will amount to $3-3½ million. Some 80% of the airline's group travel revenue is derived from scheduled flights.

For example, Pan American in October flew 505 Shriners to Europe on scheduled jet flights. They had been booked through a Southern California travel agent, and they also illustrate the trend of larger groups to select fall months for their trips to take advantage of the hotel space and rate advantages.

Siefert said his airline's approach to large firms is to sell sales incentive, convention and industrial recreation club travel. But Pan American is going hard after the small business groups, too, with the competition increasing greatly.

Transition to jets will affect the charter business of various airlines next year. Charter groups are beginning to "clamor for jets," Siefert said, but airlines at this point are reluctant to commit a great deal of jet equipment to this field. The average customer didn't know the difference between types of piston planes, but he does understand the difference between a piston and a jet, Siefert said. Companies aware of the Gibson plan with chartered jets also want jets, Siefert said.

The Gibson movement will be Pan American's biggest yet as far as revenue is concerned with the total for the trip over $1½ million.

American Airlines reports that practically every charter customer now wants a 707. Charter business this year for American has run less than 2% of the group travel. The airline says it is not a big charter operator anyway, and this year has been selling off its piston planes as well as breaking in its jets. It has handled three round-trip charter operations in its jets.

A good deal of potential charter business has been diverted into scheduled seats on the jets, according to the airline. Rather than charter a DC-6, for example, groups of about 50 persons have bought blocks of space on scheduled jet runs. American has sought out this type of business particularly at the nonstop jet route terminals to top off scheduled loads.

American reports its over-all group travel sales are up about 60% this year for an expected total at year's end of about $8½ million. Incentive travel made up a minor part of this business although the airline expects an increase and is aiming a strong sales effort at the market.

United, as another example, also finds its business meeting and incentive traffic is growing, estimating an increase of 10% this year and 15% next year.

PanAm Eliminates Pacific Division In Move to Streamline Jet Service

New York—Pan American World Airways has eliminated its Pacific Alaska Division, which effective last week was absorbed into the Atlantic Division with combined headquarters at New York International Airport. The new unit will be called the Overseas Division.

Designed to streamline Pan American's operations in worldwide jet services, the move still leaves the Latin American Division as a separate unit. Plans were made last summer to handle all jet engine overhaul and jet airframe equalized maintenance at Idlewild, and at that time it was also found that piston aircraft maintenance could more efficiently be shifted to Miami.

With the exception of Boeing Stratocruisers which serve the Alaskan operation, all piston overhaul will be transferred to Miami from San Francisco, where the Pacific Division was headquartered.

Under the divisional reorganization, Harold E. Gray, executive vice president-Atlantic Division will head the Overseas Division. Robert B. Murray, Jr., executive vice president-Pacific-Alaska Division, will represent Pan American's system, remaining on the West Coast and reporting to Juan T. Trippe, president of the airline. John T. Shannon, division manager of the Atlantic Division, will keep the same post in the new division. G. F. Maxwell, divisional manager for the Pacific Division, will move to the position of operations manager in the Overseas Division. C. S. Vaughn, who was operations manager for the Atlantic Division, will be assistant operations manager.

In maintenance, Richard M. Adams will continue as manager for the new division. Traffic and sales manager for the new division is H. F. Millie, who performed the same function for the Pacific-Alaskan Division. Pacific Alaska Operations Manager J. E. Weesner will serve as ground operations manager for the Overseas Division.

Vice President Norman P. Blake will retain his New York headquarters and continue to represent Pan American in the East Coast and Central States in his assigned area and report to Trippe.

Pacific Division crews will continue to be based at San Francisco and a sales staff for the Pacific area also will remain at that city. Many members of the former Pacific Division headquarters staff will be absorbed by the new division.

The Pacific Division maintenance function, however, will be small and will disappear as the Stratocruisers are phased out of service. About 1,500 persons, mostly maintenance personnel, will be laid-off from the San Francisco operation. Miami will handle maintenance of Pan American's converted cargo Douglas DC-7C piston aircraft and of the passenger piston aircraft until they, too, are phased out.

Jet airframe overhaul also has been assigned to Miami, although no work has yet been done because none of the carrier's Boeing 707-120s or 320s have accumulated enough time to require it.

Combining the functions of the two divisions is expected to improve efficiency of scheduling as well as maintenance as the airline makes the transition to jets. On round-the-world flights, the Atlantic Division's sphere ended at Bangkok and this formerly was the turnaround point for flights from each division. Atlantic Division jet services, however, have gone on to Tokyo to connect with the transpacific jets of the Pacific Division. Elimination of the need for turnaround and equipment change will be one of the benefits of the new system.

If the airline gets a New York-Tokyo route, flights would have to be controlled out of New York anyway and the two-division operation would lead to problems. The present West Coast-Europe polar route was a split operation between the divisions and can better be handled through the single Overseas Division, in the airline's view.

Pan American says its Latin American Division may also be consolidated into the new setup eventually.

Pan American has announced a major expansion of its jet services during this month. Round-the-world flights will depart San Francisco westbound three times weekly and depart New York eastbound with the same frequency. Five new cities to be served by round-the-world jet schedules are Munich, Vienna, Ankara, Teheran and New Delhi. Jet schedules also are being inaugurated to Australia, Bermuda, Nassau, and the Caribbean. Jet service between New York and San Juan and Miami and San Juan will be increased to daily flights.

American Regional Shift

New York—American Airlines will complete its basic reorganization plan, begun last month with a top-level management shuffle (AW Nov. 23, p. 39), by abolishing its system of regional offices. Effective Feb. 1, regional offices both for sales and operations will be discontinued.

Under the new plan, city managers will be appointed for each city in the carrier's system. Five city managers—those at New York, Chicago, Los Angeles, San Francisco and Mexico City—will report directly to the general office through F. J. Mullins, vice president-field activities. All other cities will be combined into four groups, each with a group manager to whom the city managers will report. The group managers will report to the general office. Groups are eastern, northern, central and southwestern.

IATA Files Agreement To Halt Fare Cutting

Lima—International Air Transport Assn. member airlines, in a move to bring an end to the five-year-old price-cut war in South America (AW Mar. 16, p. 36), have turned to the Latin American governments for relief from rate-sliding practices.

At a recent meeting here, IATA airlines worked out a draft agreement with non-IATA carriers who have been under-cutting regular fares by as much as 40%, calling for standardization of passenger fares on all Latin American routes. As an assurance that the rate-cutters would comply with the draft agreement, IATA carriers filed a resolution with the governments involved urging that all South American operators be required to adopt IATA-approved tariffs on all flights.

Governments showed a strong interest in the fare issue when official delegations met last January at Rio de Janeiro (AW Jan. 19, p. 39) and instructed the carriers to meet and discuss a fare structure acceptable to all airlines. The meeting, originally scheduled to be held in March in Lima (AW Mar. 23, p. 48), was indefinitely postponed and was not actually convened until late last month.

In the meantime, most IATA carriers took advantage of an IATA escape clause resolution permitting them to adopt tariffs 10% below the undercutters' fares to meet the competition of non-IATA members. The program has resulted in a serious loss of revenues, and IATA carriers are anxious to settle the issue through negotiations. However, they have warned the governments involved that, if no fare structure is agreed upon, they will take any "steps necessary" to compete effectively with non-IATA members.

The latter group has until Apr. 1—the date the new fares adopted at the traffic conference in Honolulu become effective (AW Oct. 19, p. 380)—to conform with IATA tariffs.

Profit Growth Lags Behind Revenue Rise

By L. L. Doty

Washington—Domestic trunkline operating revenues for 1959 will show a healthy 18% gain over last year but a continuing earnings squeeze will hold the profit margin on sales to about 3%.

According to estimated figures prepared by the Air Transport Assn. covering the year's traffic and financial activities, operating revenues in 1959 will total $1.789 billion as compared with the $1.8 billion originally forecast last spring by AVIATION WEEK (AW May 4, p. 26). Operating expenses, however, will jump from $1.4 billion to a record $1.7 billion, thus holding net earnings for the year at $52 million as compared with the $44.7 million net profit last year and to the all-time high of $63 million in 1955.

In estimating the profit figure, ATA statisticians eliminated any possibility of a profit during the fourth quarter of the year on grounds that expenses during this period normally spiral upward at a much greater rate than they do in the other three quarters. Net earnings in the third quarter, when the increase in revenues was a fraction higher than the increase in expenses, were $22.3 million—highest for any three-month period of the year.

Net operating income in the third quarter for all 12 domestic trunklines was $46 million. However, a factor that is taking on rapidly growing significance and will carry a major influence on airline balance sheets in the future—net interest on long term debt—will continue to depress net earnings as turbojets and turboprops are delivered in increasing numbers. Long-term debt interest in the third quarter climbed 45% over the same period of last year to reach $8.7 million.

A total of 38 turboprop transports and 155 turbojet transports will be delivered in 1960. As of Nov. 1, 155 turboprops and 68 turbojets have been delivered to U. S. carriers.

With a total of $1.6 billion committed for turbine equipment ordered for delivery between 1958 through 1960, the industry continues to face the problem of attracting sufficient capital to cover purchase, transitional and initial operating costs as long as a low rate of return on investment exists. Equity financing is not viewed as a practical step at this time since trunkline stock listings generally hover at low levels.

Modest dividends on common stock, coupled with an increasing use of stock dividends to convey stability, and the slight 3% profit margin on sales contribute little toward drawing investor interest in airline stocks. By contrast, profit margin on sales for a group of industrials during the first six months averaged 5% and railroads, during the first nine months, averaged 8%.

In addition, conservative brokers have suggested that there is a high degree of speculative activity in the markets that should be watched carefully. Airline stocks, lacking historic earnings records, will not be selected by cautious investors who heed this warning and seek out listings that compare favorably with blue chip-type stocks.

In the past, airline stocks have attracted attention as growth stocks. The introduction of jet transports last year added to the reputation of airline stocks as good growth investments, and this factor may help keep the selling price of airline stocks in a favorable ratio with their book value.

This ratio, however, declined during the year and has weakened the financial base the airlines need for refinancing.

As a consequence, long-term financing is likely to serve as a major source of capital for the industry during the next few years.

Gross Revenues

Gross revenue for all U.S. carriers is estimated by AVIATION WEEK at $2.6 billion as compared with actual gross revenue of $2.2 billion in 1958. A gross of $2.9 billion is forecast for 1960.

Traffic-wise, the entire U.S. scheduled airline industry will report a prosperous year. According to the ATA estimate, the number of passengers carried during the year will reach an estimated 54.9 million—an encouraging increase over the 49 million handled in 1958 which was a .5% drop from the 49.3 million carried in 1957.

Revenue passenger miles for the total U.S. scheduled airline industry will climb to 36.2 billion from the 31.4 billion recorded last year. Domestic trunkline revenue passenger miles will hit 28 billion as compared with 24.4 billion last year. Biggest increase will be recorded by the three helicopter airlines with a total of 7.6 billion revenue passenger miles—almost double the 4.885 billion handled last year.

Local service carriers passed the one billion mark for the first time in their history. Revenue passenger miles for the 13 airlines were 1.033 billion as compared with 820 million last year.

Revenue passenger miles for the total domestic industry—trunklines, local service and helicopter carriers—will be 29 billion as compared with 25 billion last year.

Total international and overseas revenue passenger miles for the year will rise to 7.7 billion contrasted to the 6.2 billion operated last year.

The sharp increase in revenues and revenue passenger miles is attributed largely to the generally prosperous state of the economy. Even the prolonged steel strike failed to have any marked influence on traffic activities during the year. Business travel was high, but the rapid increase in tourist revenue passenger miles suggested that deeper inroads into the tourist market are being made.

To a great degree, the introduction of turbojets and turboprops and the accompanying sales and advertising campaigns are believed to be important reasons for the return to the industry's normal growth pattern that came to a virtual standstill in 1958.

This is borne out by the fact that the bulk of the net operating profit during the third quarter consisted of the earnings of the two major turbojet operators at that time: TWA and American. These carriers alone accounted for about $26 million of the $46 million in net operating profits reported by the 12 trunklines for this quarter.

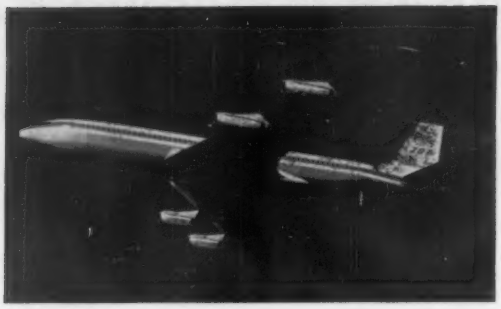
Four carriers—Capital, Eastern, Northeast and National, none of which was operating turbojets during the third period—reported third quarter losses to the Civil Aeronautics Board. All four carriers are operating turboprop equipment.

Continental Airlines, which operates the Boeing 707-120 on its major routes, and Western, which operates the Lockheed Electra, showed substantial net operating profits. United, which began turbojet service in September with the DC-8, showed high profits as did Northwest which is still serving its routes with piston-engine equipment.

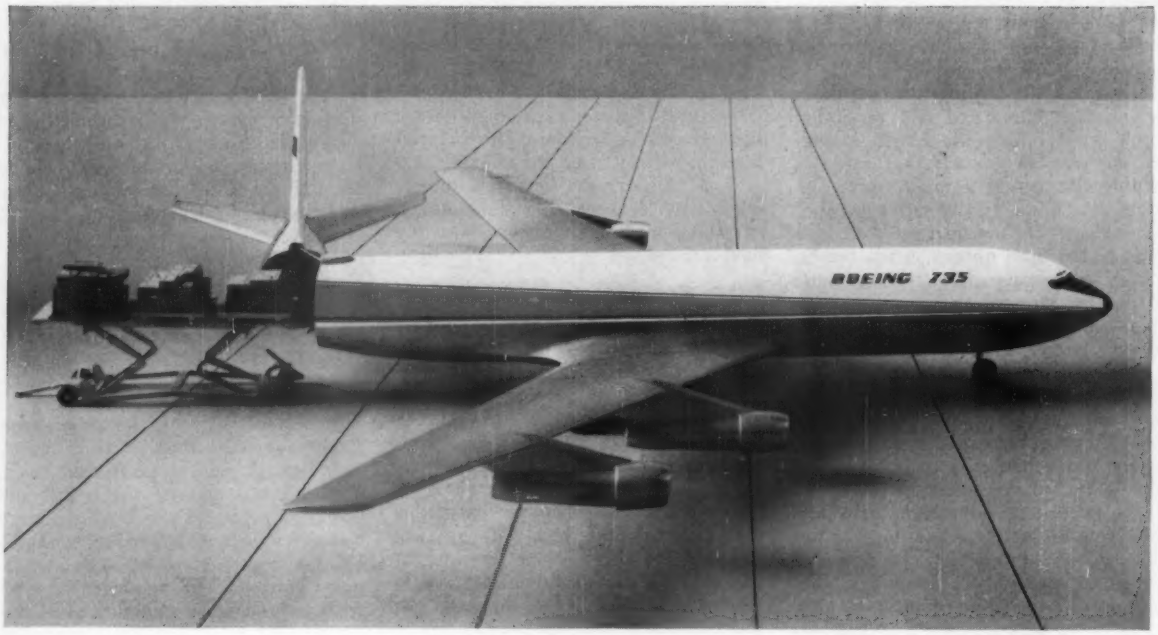
Dispatchers Protest Weather Advisories

Washington—Air Line Dispatchers Assn. lodged a strong protest with the Federal Aviation Agency last week over the volume and accuracy of U.S. Weather Bureau "flash advisories."

The union said the volume of the advisories consumes an inordinate amount of the dispatchers' time. Too often, ALDA said, the reports do not check out with actual weather experienced. The union said that, in some instances, dispatchers have been forced to consider calling a complete standstill to airline operations because of the volume of turbulence forecasts ranging from severe to extreme from the Weather Bureau. In many instances, it charged, the forecasts were unduly alarming.



Boeing 735 can carry cargo for 3¢ a ton-mile



Photograph of scale model of Boeing 735

The Boeing 735 cargo jet, capable of transporting freight for as low as three cents a ton-mile, offers unparalleled opportunities for the development of world-wide air cargo potentials.

Based on the long-range, proved-in-service Boeing 707 Intercontinental, the new cargo jet will be capable of carrying 100,000 pounds of cargo across the U.S. in five hours. It will be powered by turbofan engines, providing increased take-off performance for short-field operations, as well as economy at high speed and long range. The new Boeing 735 cargo jet can be delivered in early 1962.

The swing-tail 735 is part of an advanced integrated terminal-to-terminal cargo system now under development by Boeing's Transport Division. The system includes ground transporters, special pallets, pre-loaded containers and other equipment designed to expedite loading, unloading and ground-handling operations.

Air-conditioned and pressurized cargo space totals 9,000 cubic feet. Range, with 100,000 pounds of cargo, is more than 3,000 miles. With a work rate four times that of current piston aircraft, the 735 could, in one week, carry as much cargo across the U.S. as a 40-car freight train.

BOEING 735 CARGO JET

Retirement Rules Fight Planned By ALPA in Court, Congress

Washington—Air Line Pilots Assn. spokesmen said last week that they will seek both legal and congressional support in the union's efforts to stave off a new Federal Aviation Agency regulation requiring airline pilots to retire at the age of 60 effective next Mar. 15 (AW Dec. 7, p. 45).

At the same time, ALPA President C. N. Sayen issued a strongly worded protest against other FAA regulations establishing higher copilot qualifications, which Sayen said amount to a "dilution of original agency proposals and an ineffectual compromise." He charged that FAA had "evidently decided to bow to the air carriers' objections to more adequate rules based largely on cost." The union head said that his members feel the combination of retirement and copilot qualification regulations indicate that FAA has "missed the air safety point involved."

Sayen said ALPA is moving "immediately" to challenge FAA's authority to issue the age ruling by seeking an injunction against the agency in the federal courts challenging both the legality of FAA's administrative procedures in the action and the agency's right to deprive pilots of their "property rights" without due process of law or hearings. FAA earlier noted that a request by the union for a hearing on the regulations was not granted because questions raised by ALPA had been covered earlier in comments gathered on the proposed regulation so that no new information could be expected.

The pilots' union said it also will enlist congressional aid to defeat the measure and favors an investigation and definition of FAA powers by Congress when it reconvenes next month.

While FAA's new regulation for copilot training and qualifications have been expanded, Sayen contended that they have been diluted from those originally proposed by FAA, and long sought by ALPA.

The problem of pilot in-flight incapacity, the pilots maintain, is not an "arbitrary" retirement age based upon unproved findings submitted by FAA but the high number of incapacities resulting from "transitory" and less serious illnesses, which ALPA claims can be experienced at any age. ALPA said a recent union survey revealed that its members encountered 1,552 such cases of stomach aches, diarrhea and food poisoning over a one-year period. Results of the survey, it contended, point to a need for a "fail safe" concept of operation which demands that other crew members be qualified to assume control of the aircraft in emergencies.

ALPA had urged that copilot training and qualifications be expanded to require a type rating for each aircraft being flown, proficiency checks each six months and creation of a new airline transport copilot license requiring at least 1,000 hr. of dual and solo flight time as pilot on aircraft of less than 12,500 lb. or 750 hr. on larger planes. The union also recommended that any other crew member with a commercial license and instrument rating be allowed to accrue 50% of his scheduled flight time towards a copilot license.

ALPA contends that the new regulation adopted fails to ensure that copilots will be qualified on their respective aircraft since they are not required to acquire a type rating, as are pilots in command.

"These deficiencies," Sayen said, "still leave the situation where an airline can hire a pilot with 200 hr. of 'Cub' time, a commercial license and instrument rating, give him some undefined training, check him out on one type of airplane, assign him to fly in a completely different type and then not check his proficiency for a year."

British Bloc Integrates Operations

New York—In an apparent move to combat the competitive threat of Europe's Air Union, a British bloc composed of three global airlines will be established Apr. 1 to permit integrated operation and the pooling of revenues on routes between New York, London and the Far East.

The three airlines—British Overseas Airways Corp., Air-India International and Australia's Qantas Empire Airways—will operate the bloc as a closely coordinated sales, traffic and scheduling unit for the primary purpose of increasing their shares of "the world's international traffic in the jet age." The agreement is similar to that BOAC reached earlier this month with Trans-Canada Airlines (AW Dec. 7, p. 50).

Under the pooling arrangement, revenues probably will be split among the three carriers in ratio to the number of seats offered over a given period—the system normally adopted under such programs. Schedules will be arranged to avoid simultaneous departures and arrivals of flights and permit full competitive coverage of flight operations over a 24-hr. period.

Possibility that the arrangement will create a strong bloc within International Air Transport Assn. conferences and meetings is not being overlooked by industry observers. BOAC gained much of its strength in its fight for lower fares at the Honolulu IATA traffic conference in October (AW Oct. 29, p. 28) from the five Commonwealth airlines it won over to its side.

Air-India took a strong stand in opposition to BOAC at the IATA conference general meeting on the fare and seat configuration issues. Fare cuts by BOAC on the Far East routes could feasibly force Air-India and other carriers competing with BOAC to follow suit for competitive purposes. However, this does not suggest—nor does the agreement imply—that Air-India must change its position on these issues within the traffic conference. The agreement also calls for the consolidation of sales efforts, interchange of tickets and joint use of ticket sales offices. It is possible that a ticket office competitive to another within the bloc will be closed. Each carrier will retain its identity but competition with one another will be eliminated.

Both Air-India and Qantas stand to gain in the expansion of their sales efforts in the lucrative U. S. travel market because of the large number of sales offices now operated by BOAC in this country. Air-India currently relies almost entirely on travel agents for U. S. sales and will be spared the cost of implementing new sales facilities next year when it plans to begin its New York-London service.

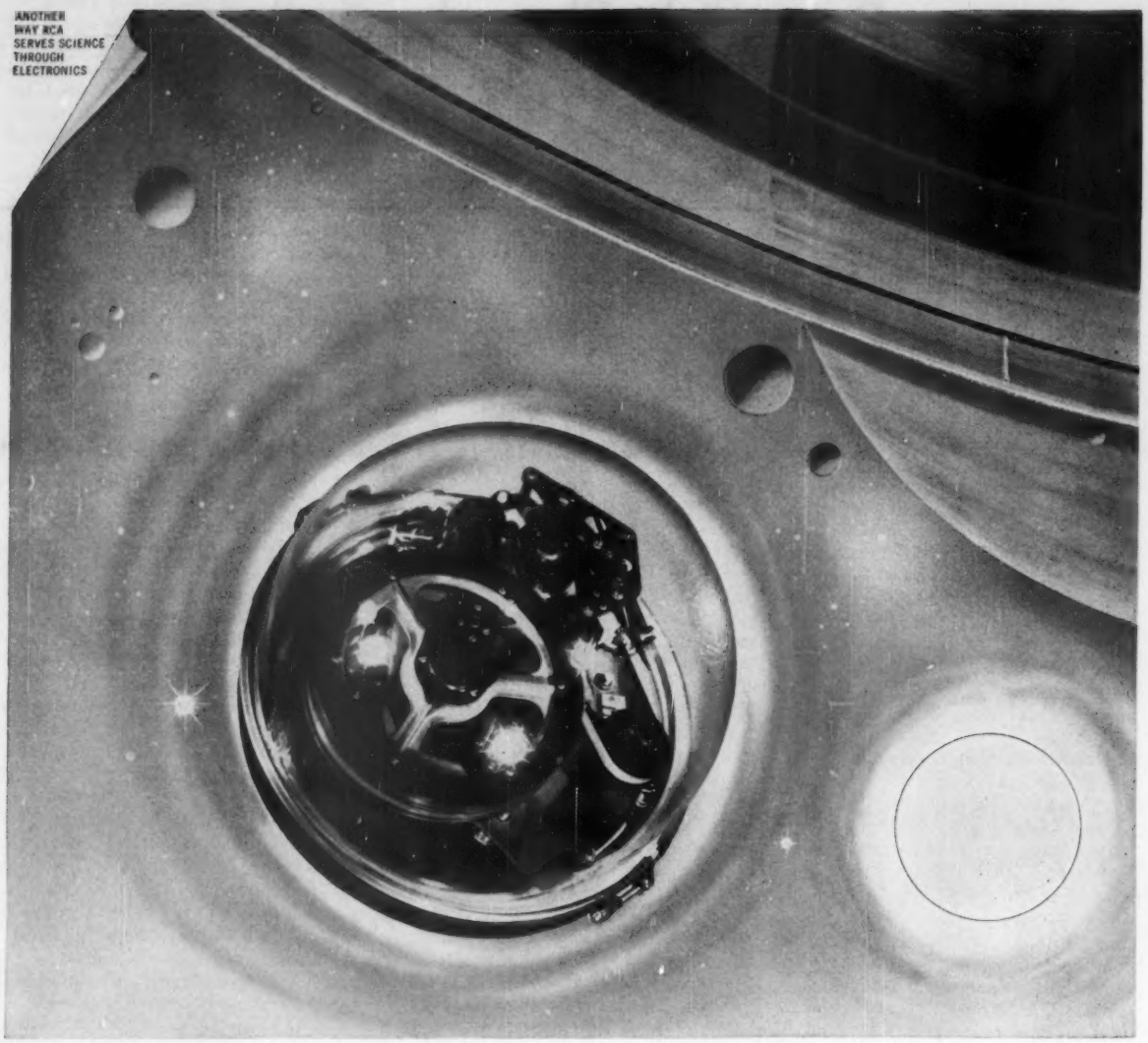
Since Trans-Canada operates its transatlantic route through the Montreal gateway also served by BOAC, it was not included in the agreement signed with Air-India, which will operate out of New York, and Qantas, which serves both the New York and San Francisco gateways.

Court Instructs CAB To Reconsider Award

Washington—U. S. Court of Appeals last week directed the Civil Aeronautics Board to reconsider its award of a St. Louis-Miami route to Trans World Airlines on grounds that transcontinental factors were injected to an area route case.

TWA was awarded the route in the Great Lakes-Florida Route Case last December (AW Dec. 15, p. 39). The decision was contested by American Airlines. In a 26-page opinion, Chief Judge E. Barrett Prettyman found that the Board had limited the scope of the case properly but had taken transcontinental aspects into account in reaching a decision.

ANOTHER WAY RCA SERVES SCIENCE THROUGH ELECTRONICS



Systems Development for Space Technology:

Magnetic Tape Recorders

Develop a tape recorder capable of handling video signals, but light and compact enough to fit in a satellite. Design for minimum power drain. Make the unit rugged to stand up under launching stresses and operate unattended for the life of the satellite.

From requirements such as these, Astro-Electronic Products Division developed the video tape recorder pictured above.

The entire unit, including electronic circuits, weighs less than nine pounds. It is designed to accept video signals from a satellite TV camera and deliver at its output a frequency-modulated carrier suitable for input to a transmitter. Weight and power drain in the tape transport are reduced without sacrificing tape motion stability. Normal braking methods are eliminated in favor of a constant-tension spring coupling between reels which keeps tape tension constant. The entire system is designed to operate normally in the vacuum of space.

Video or digital data tape recorders are typical of the many specialized systems developed at AEP to spearhead man's advance into space. Whether your problems involve electronic instruments, mechanical sub-systems, entire satellite systems, or the supporting ground control equipment, AEP can help you find the answer.

Watch for Camera Systems for space applications...another AEP capability

ASTRO-ELECTRONIC PRODUCTS DIVISION

Radio Corporation of America — *Princeton, N. J.*

BELL 47G with vertical lift of 450 lb. tows balloon supporting one-ton payload. Balloon contributes 1,600 lb. of lift.

Balloon Supplements Helicopter's Lift

Experimental helicopter-towed balloon named helibarge promises from 5 to 10 times the lift capability of helicopters alone while offering speed up to 38 mph. and range up to 100 mi. Technique has been devised and tested by World Wide Helicopters, Ltd., and the Mechanical Division of General Mills, Inc.

Idea was conceived as a means of extending helicopter capability in World Wide's international contract transportation business. Combined lift of helicopter and balloon makes possible low ton-mile costs and good payload-power ratio for a small initial equipment investment relative to the lift capability improvement. General Mills supplied the balloon experience.

System has been proposed to U.S. Navy. Designers think it might be useful as a ship-to-shore cargo lighter with the additional advantage of being able to cross the beach and deliver cargo some distance inland. Usefulness in support of Marine Corps vertical envelopment operations might be limited by vulnerability to enemy fire. Lifting gas for the balloon must be helium, hydrogen or dissociated ammonia.

World Wide officials say there are comparatively few jobs on which a helicopter as large or larger than the Sikorsky S-58 can operate profitably without subsidy. Experimental helibarge concept should enable an S-58 costing $250,000 and an aerodynamically shaped balloon probably costing less then $100,000 to carry a payload of 20 tons at an airspeed of 30 mph. No seriously proposed helicopter designs have yet been announced which could carry this weight alone. When they become available, they will probably cost well over a million dollars.

World Wide Helicopters specializes in penetrating primitive areas and is now billing itself as a "general transportation and service contractor." This means the company is prepared to supply economical and effective transportation ranging from dugout canoes to modern aircraft. Applications for the helibarge should roughly correspond to those for the helicopter alone, except that speed and range will be reduced for the sake of increased payload. World Wide has made a successful business of dropping massive oil drilling rigs into jungle clearings far from any surface transport route. If helibarge could enable the company to freight heavier equipment, clients exploring for oil could use equipment capable of drilling to greater depth, or could reduce time spent in disassembly and reassembly of the equipment.

Another potential application is salvage of aircraft forced down intact in inaccessible country. By avoiding the necessity of disassembling the downed aircraft, it should be economical to salvage aircraft which would otherwise be written off because of the high cost of recovery.

Carrying Timber

World Wide is studying use of helibarge to render economical a plan to log off inaccessible stands of timber in the Far East. Cost of building roads to the area over rugged terrain would eliminate all the profit in the operation. Company officials think helibarge could be used to fly in a small sawmill and fly out rough milled lumber. The same economics might apply to marginally profitable mineral deposits in primitive areas. The helibarge system capable of supporting operations such as these is supposed to be cheaper than a fleet of helicopters of equal capability. Aside from the helicopter and the balloon, components of the helibarge system are simple and can be procured or fabricated easily.

Initial tests were conducted with a nylon-shrouded spherical polyethylene balloon inflated with hydrogen and teamed with a Bell 47G helicopter. Approximately a ton of weight was suspended from the balloon and helicopter towline was attached to the apex of the balloon. Takeoffs and landings were smooth and easy. Straight and turning flights were made to an altitude of 1,000 ft. However, the balloon began to porpoise as speed increased and became uncontrollable at 15 mph. The tests demonstrated that a helicopter with a vertical lift capability of only about 450 lb. could transport a one-ton payload with assistance from the balloon supplying another 1,600 lb. of lift.

Second phase of tests used a General Mills blimp-shaped Aerocap balloon with a fineness ratio of 3 to 1. The aerodynamic shape of the Aerocap made it stable and maneuverable. Airspeed of 38 mph. was achieved.

This speed makes it possible to operate in winds up to 20 mph. The balloon can be inflated outdoors in moderate winds and is airworthy enough to be flown in winds up to 50 mph. Fabric of the balloon can be patched without deflating it. In high winds the balloon must be tethered at an altitude of approximately 150 ft.; it is vulnerable to gusty cross winds when close to the ground. Size and weight of the balloon are a handling problem and means must be devised to cope with it before and during inflation.

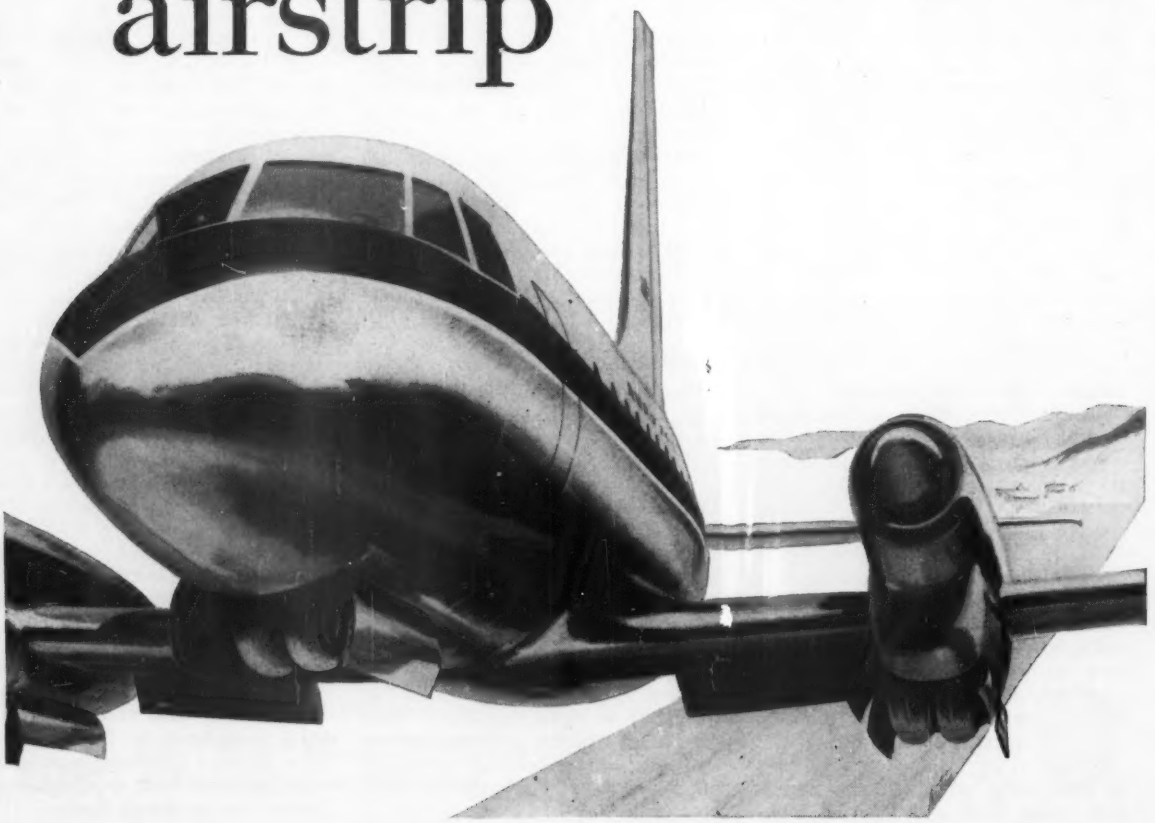
Balloons would be deflated for transportation to the site of the new job. However, as long as a job lasts the balloon would be left inflated. A large volume of gas is needed for each initial inflation and small volumes must be added periodically to compensate for losses. Support equipment must include a gas generator with an adequate production rate or storage bottles.

AVRO 748 AVRO 748 AVRO 748 AVRO 748 AVRO 748 AVRO 748

Some aircraft operating today are severely limited in the amount of payload and/or fuel that can be carried from hot and high airfields. The low-cost Avro 748 can operate from these 'critical' airstrips without restriction on useful load. Where restrictions must be applied, these are much less severe than for any other aircraft in this class. The Avro 748 takes off and lands safely on semi-prepared surfaces, and can operate with full payload from airfields of very limited runway length. At maximum take-off weight of 33,000 lbs. (14,970 kgs.), the total distance to take off and reach a height of 35 ft. (10.69 m.) is 2,520 ft. (768 m.) in International Standard Atmosphere conditions at sea level. This aircraft can also take off in 3,500 ft. on one engine. **HAWKER SIDDELEY AVIATION**
32 Duke Street, St. James's, London, S.W.1.

wherever there's an airstrip

There can be an **AVRO 748**



Airline Traffic—October, 1959

	Revenue Passengers	Revenue Passenger Miles (000)	Load Factor %	U. S. Mail Ton-Miles	Express Ton-Miles	Freight Ton-Miles	Total Revenue Ton-Miles	% Revenue to Available Ton-Miles
DOMESTIC TRUNK								
American	725,578	521,709	69.8	1,996,142	1,059,957	10,037,974	63,174,338	61.6
Braniff	186,916	80,740	55.1	374,540	179,290	679,008	8,979,565	46.7
Capital	337,014	135,086	57.7	549,023	335,818	465,035	14,290,733	52.7
Continental	109,203	71,022	50.9	137,830	104,576	318,801	7,367,662	39.6
Delta	262,126	127,580	54.2	429,583	342,209	1,423,396	14,458,703	49.7
Eastern	716,739	357,317	46.93	1,121,724	585,297	1,706,737	37,796,307	38.64
National	136,001	67,634	45.7	279,769	72,901	631,931	7,521,636	38.8
Northeast	98,957	34,438	42.9	115,059	50,616	124,085	3,580,254	35.4
Northwest	158,802	114,422	53.1	629,556	334,100	1,530,184	13,477,301	47.5
Trans World	462,427	410,842	69.8	1,667,410	931,869	3,593,017	45,549,907	59.8
United	597,709	387,490	65.3	2,358,540	1,050,614	6,491,718	47,104,836	59.3
Western	154,124	82,253	59.6	339,837	98,911	325,876	8,648,090	52.4
INTERNATIONAL								
American	9,014	8,968	52.9	11,524	592	208,858	1,136,884	54.8
Braniff	3,995	7,549	48.6	23,686	.....	113,438	959,296	45.9
Caribbean Atlantic	23,279	1,575	61.2	1,750	.....	4,919	171,636	67.0
Delta	3,298	4,022	41.8	7,118	.....	34,313	489,638	37.6
Eastern	29,904	43,645	48.87	79,883	.....	192,531	4,772,490	47.50
Mackey	7,728	1,671	46.2	.....	132	4,800	179,936	45.2
National	5,717	3,932	41.2	10,511	9,261	64,424	504,444	39.7
Northwest	15,719	26,599	45.5	1,326,022	24,907	1,162,372	5,350,295	50.8
Pan American								
Alaska	4,000	4,021	42.6	42,985	.....	163,166	644,980	46.8
Atlantic	116,033	166,812	72.0	1,344,618	.....	3,639,703	22,430,847	64.9
Latin America	95,489	108,284	60.6	426,065	.....	5,362,340	16,479,537	63.5
Pacific	27,810	101,077	73.6	1,472,501	.....	2,338,890	14,416,385	67.2
Panagra	11,835	16,318	60.9	73,592	.....	424,401	2,280,254	63.6
Resort	.....	.....	.....	.....	.....	3,137,353	3,137,353	80.1
Trans Caribbean	6,369	10,222	82.7	.....	.....	767,190	1,599,094	88.0
Trans World	21,836	59,349	59.4	891,404	.....	1,275,496	8,411,080	59.2
United	8,169	20,327	65.7	146,722	5,365	91,638	2,311,541	65.1
Western	4,145	6,448	59.4	8,677	.....	13,630	700,317	61.6
LOCAL SERVICE								
Allegheny	55,168	9,759	48.9	13,225	26,748	36,182	1,007,703	47.8
Bonanza	20,462	3,076	44.1	6,674	2,589	8,468	502,873	46.4
Central	15,188	2,881	36.9	7,437	4,498	11,050	299,197	33.0
Frontier	28,633	7,470	35.8	26,393	12,002	71,335	830,447	40.4
Lake Central	23,177	3,699	44.7	4,210	21,699	.....	379,427	48.4
Mohawk	54,456	10,578	55.2	12,573	24,406	21,742	1,068,108	55.8
North Central	85,559	14,972	44.77	37,399	54,299	31,798	1,577,592	45.81
Ozark	50,784	8,986	46.1	15,629	27,440	35,245	937,727	48.8
Pacific	44,332	10,224	56.0	15,459	4,560	9,574	1,004,926	53.8
Piedmont	43,844	9,478	48.5	11,048	14,164	18,029	951,628	49.3
Southern	24,180	4,336	35.2	12,532	13,165	18,788	460,130	37.2
Trans-Texas	27,065	6,466	38.4	22,588	13,470	46,000	699,861	39.8
West Coast	39,680	7,561	41.07	13,029	5,035	16,794	756,920	40.41
HAWAIIAN								
Aloha	25,309	3,682	56.9	2,543	.....	5,308	302,802	53.7
Hawaiian	33,632	5,516	56.5	9,808	.....	183,846	657,961	55.3
CARGO LINES								
AAXICO*	.....	.....	.....	.....	.....	.....	.....	.....
Aerovias Sud Americana	.....	.....	.....	.....	.....	724,482	724,482	83.4
Flying Tiger	1,147	2,582	84.2	83,910	107,847	9,792,331	10,242,242	79.6
Riddle								
Domestic	.....	.....	.....	34	32,843	1,400,061	1,437,505	76.2
Overseas	.....	.....	.....	.....	.....	1,149,412	1,153,828	86.2
Seaboard & Western	2,049	7,821	100.00	509,059	.....	3,691,294	4,990,320	76.72
Slick	742	3,333	79.1	.....	.....	6,026,228	6,359,555	92.2
HELICOPTER LINES								
Chicago Helicopter	22,265	387	55.0	1,264	.....	.....	38,246	45.8
Los Angeles Airways	2,679	97.9	58.3	4,079	2,430	.....	15,875	66.8
New York Airways	10,886	210	52.9	1,372	850	597	22,865	51.9
ALASKA LINES								
Alaska Airlines	9,906	7,585	55.5	61,327	3,971	451,383	1,260,355	60.3
Alaska Coastal	3,738	410	55.3	3,880	.....	4,514	50,671	64.5
Cordova*	.....	.....	.....	.....	.....	.....	.....	.....
Ellis	4,120	268	56.9	2,445	.....	2,872	32,929	69.8
Northern Consolidated	1,998	673	40.0	34,026	.....	56,274	165,375	59.4
Pacific Northern	7,838	6,885	36.0	103,786	6,554	273,116	1,132,620	48.2
Reeve Aleutian	907	886	34.3	48,789	.....	50,869	197,397	61.7
Wien Alaska	2,337	719	20.9	45,506	.....	65,802	185,890	40.2

* Not available.

Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.

Pan American, National Stock Plan Vetoed in Examiner's Proposal

Washington—Abandonment of stock exchange and option purchase plans incorporated in a three-part agreement between Pan American World Airways and National Airlines (AW Nov. 10, 1958, p. 39) has been recommended by a Civil Aeronautics Board hearing examiner on grounds that approval of the stock phase would result in control of National by Pan American and in the indirect granting of a domestic route to the larger carrier.

At the same time, Examiner Leslie G. Donahue said he approved of National's two-year lease of Pan American Boeing 707 jet equipment now in its second and final year and recommended approval of a long-term lease under which the carriers would enter into a mutual lease of 707 and Douglas DC-8 equipment for a 10-year period beginning next year.

Donahue, however, conditioned his approval of the long-term lease on an extensive plan that would require the airlines to divest themselves of a mutual exchange of 400,000 shares of stock each and the elimination of an option permitting Pan American to purchase an additional 250,000 shares of National stock. Here's how abandonment of the stock plans would be accomplished under the Donahue proposal:

- **No later than 30 days** after a final CAB order in the investigation, the carriers should return the 400,000-share blocks of stock already mutually exchanged and cancel the additional stock option purchase provided for Pan American. If all or part of the option has already been exercised, National should repurchase the shares for the same price at which they were sold.
- **Within the same period,** the carriers should file any alternate plans for the sale of stock held by each other.
- **Any plan submitted** will be subject to CAB approval and require disposal of the stock by sale within a one-year period from the date of approval.
- **During the period** prior to the actual sale the stock must be held by an independent trustee who will have sole rights to vote the stock with a majority of stock at stockholders' meetings of the respective airlines.
- **Plan submitted** must not permit any pro rata distribution of stock to the shareholders of either carrier.
- **Stock may be sold** through the New York Stock Exchange directly to selected purchasers not purchasing for immediate resale or to underwriters and dealers, with a proviso that no one person or group may acquire more than 10,000 shares.
- **Stock may not be sold** to any person, firm or corporation where the carriers or their trustees believe purchaser acquisition would require prior CAB approval.
- **Any shares** of National stock acquired by Pan American through its purchase option must be placed with an independent corporate trustee and later sold within one year of the date of purchase. During this period, the stock would be voted by the trustee, along with a majority of all other National stock, in the same manner as stock exchanged between the carriers.
- **Any agreement** between the airlines and trustees must be approved by CAB.
- **Both carriers** must file a quarterly report with the Board during the period of stock disposition showing the number of shares of stock sold and the names and addresses of the purchasers.
- **CAB must retain** jurisdiction over the proceeding as a follow-up to its final order in the case.

Basis of Donahue's argument is that Pan American already has attained indirect control of National through the joint exchange of 400,000 shares of stock in December, 1958. Pan American, he said, holds about 25% of National's stock and has become its largest single shareholder. Exercise of its purchase option would give the international carrier a total percentage of 30%, Donahue said, as compared with National holdings of Pan American stock which amount to only 6%.

Holding of the exchanged shares for a period of eight years by an independent trustee would have little effect on the question of control over National, Donahue said, since National officers, who are elected for a period of only one year, would be unlikely to oppose the desires of Pan American as the largest stockholder in the company.

Approval of the stock transactions, the examiner said, also would amount to the "fulfillment of an ambition long cherished" by Pan American . . . that of gaining a domestic route, between Boston, New York and Miami, even though the airline's past applications for a domestic route have been repeatedly denied by the Board.

Hawaiian Carriers Reap Bonanza From Sightseeing Over Volcano

Hilo, Hawaii—Hawaii's two local airlines last month reaped an unexpected revenue bonanza brought about by thousands of sightseers eager for an aerial view of a volcanic eruption in the ancient crater of Kilauea Iki about 35 mi. from here.

A total of three eruptions, the longest of which lasted seven days and nights, provided both Aloha Airlines and Hawaiian Airlines with top load factors in a steady flow of 440-mi. round-trip excursion flights between Honolulu and the rim of the crater. The latest eruptions were no match for the three-month eruption of the crater in 1955 when the spectacle attracted enough passenger traffic to pull both carriers out of the red for that year.

Nevertheless, last month's volcano skyrocketed revenues and set new November traffic records as both carriers pressed their DC-3 aircraft into service. Hawaiian Airlines also pulled its DC-6B into the operation in the first time this aircraft has seen inter-island service.

During the month, Aloha carried a total of 30,710 passengers as compared with 13,377 in the same month of last year—a 130% increase. Hawaiian hauled 45,899 passengers in the same period as compared with 29,007 passengers in November of last year.

Both carriers made their most spectacular gains during the first eruption which lasted a full week. During the week, Hawaiian carried 10,651 passengers for total revenues of $157,500 as compared with the 2,647 passengers carried and $46,725 in revenues collected during the corresponding week of 1958 on its Hilo operation. Aloha during the week carried 4,288 passengers for total revenues of $102,159.

Aloha operated the first flight over Kilauea Iki on Nov. 14 when lava first spurted out of the crater at 8:00 p. m. One of its fleet of three 44-passenger Fairchild F-27 turboprop transports left Honolulu at 11 p. m., circled the volcano and returned at 1:30 a.m.

Hawaiian was the first to exploit the volcano's revenue potential. First com-

BOAC, TCA Pact

London—Integration of schedules for passenger and cargo services and interchangeability of tickets have been announced by British Overseas Airways Corp. and Trans-Canada Air Lines, in an agreement which comes into effect Mar. 1. Offices of both operators will conduct business on behalf of each other.

Move is interpreted, at least in part, as BOAC's answer to Air Union, the combination of French, Italian, Belgian and West German airlines which comes into operation shortly.

mercial flight took off from Honolulu at 12:30 a. m., and by 2:30 a. m. the carrier had sent three 52-passenger Convair 440 flights to circle the rim. Despite the late hour and the short notice, Hawaiian's Honolulu terminal, located on the opposite of the field from the main terminal, was jammed with prospective passengers.

During the following seven days, both carriers conducted vigorous advertising and promotional campaigns to maintain the heavy traffic flow. Hawaiian pitched a large tent near its loading gates to accommodate overflow crowds. Passengers waiting for flights were given a preview of their trip in the tent—continuous color movies of the eruption.

Here's how the two airlines operated during Kilauea Iki's flaming week:

• **Hawaiian Airlines** made 51 excursion flights from Honolulu around the volcano and back; seven flights from Hilo to the volcano and return; 136 round trips from Honolulu to Hilo, jumping-off point for surface trips to Kilauea Iki.

• **Aloha** made 23 excursion flights from Honolulu around the crater and return; seven flights from Hilo to circle the crater, and 90 Honolulu-Hilo round trips.

On the sixth day of the first eruption, one Convair of Hawaiian Airlines and two of Aloha's transports were showered with cinders from a column of lava and rock that was shot up 1,150 ft. by the volcano. Windshields of all three planes, which were flying an estimated 1,000 ft. above the crater area, were cracked, but no further damage was inflicted.

Alitalia Doubles Atlantic Traffic

New York—Alitalia carried 57% more North Atlantic passengers during the first 10 months of 1959 than during the same 1958 period. Total was 35,275. Capacity was up 40% to 57,103 seats.

The Italian carrier expects to double its available seats and its passenger business next summer with a publicity assist from the 1960 Olympic Games, to be held at Rome in August. Alitalia plans to introduce Douglas DC-8 jet service on the North Atlantic Apr. 1, and to offer daily transatlantic jet schedules and one daily DC-7C flight during the 1960 peak season.

El Al Israel Airlines carried 12,618 passengers in summer 1959, up from 9,261 the previous June through September period. Capacity was up from 12,748 seats to 18,770 seats. The 1958 and 1959 El Al figures were inadvertently transposed in an AVIATION WEEK roundup of North Atlantic traffic (AW Dec. 7, p. 38).

Wind, Noise and a Hot Water Bottle

In an effort to shield citizens living in the vicinity of Los Angeles International Airport from aircraft noise, the FAA in Draft Release 59-17 proposes drastic restrictions in the use of that airport. If adopted, the regulation would require all takeoffs and landings to be made to the west when the wind is less than five knots. Pilots deviating from this procedure would have to submit a written report within 48 hr. stating their reasons for such deviation. Granting that the prevailing operational direction at Los Angeles is west, this proposal has many bad features. It indicates a surprisingly naive knowledge of the operation of turbojet aircraft as well as the flow of traffic at a major terminal; it assumes a "guilty until proven innocent" attitude, and it provides no safeguards against certain operating hazards. It is a proposal to which I can only register a loud "No."

This plan is an effort to expand the scope of the "preferential runway" system begun in the New York area about a decade ago and now used throughout the country. Used with mature operational judgment, this system is a good thing as it provides for the use of certain runways when wind conditions are not a dictating factor. Unfortunately, this plan has been badly overdone. Now the FAA apparently feels that it is necessary to expand the system by force.

Wind Factor

The Los Angeles proposal is, of course, specifically aimed at jet takeoffs—the most critical phase of today's airline flying. The takeoff of a transcontinental jet can only be legally accomplished by taking into account every fraction and decimal point of the wind, runway, temperature, fuel, etc. Every jet pilot still blanches when recalling many of these "legal" departures. The FAA now has the temerity to suggest that we disregard a wind factor of some 10 kt. (The difference between a five knot headwind and five knot tailwind.)

Furthermore, the proposal is quite vague about everything except pilot punishment. Nothing is said about who certifies the wind. Is this a remote reading, from the airport surface or from high atop the tower? Is this a hasty instrument "interpretation" by a tower trainee or a precision record, in degrees and tenths of a knot velocity, printed on a time-stamped tape? Let it be remembered that tower controllers are understandably reluctant to reverse the flow of traffic at a major terminal.

Some amazingly devious wording is used to circumvent a true report of the wind. Southwest takeoffs at La Guardia, for instance, will be continued under the guise of "wind variable, occasionally eight knots" until a persistent questioner elicits the information that the wind is indeed "from the north quadrant." But tailwind operations continue regardless of this meteorological fact.

Jet takeoffs are accomplished by "rotating," that is, lifting the nose, at a specific point down the runway. Otherwise, one goes smashing through the boundary fence. If all goes well, however, one clears obstacles at the boundary by several feet. But the Los Angeles runway, at the rotation point, starts uphill—some 25 ft. in 4,000. So the jet doesn't fly when advertised—it sort of taxis uphill out of Los Angeles International.

I note with interest that, over in another branch of FAA, the people are so worried about the ability (more precisely, lack of ability) of turbojets to stop inside airport boundaries on aborted takeoffs and icy landings that they are investigating some rather extreme devices. One of these gadgets is a water-filled neoprene diaphragm, several hundred feet long (and worth more than half million dollars) on top of the runway. Supposedly it will "retard" the passage of a jet. And so it goes. We will watch with interest this battle between the wind and the hot water bottles.

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AIRLINE OBSERVER

▶Scheduled airlines this year will report a record high in the number of accident fatalities. Thus far this year, there have been 17 fatal accidents in scheduled airline operations—329 passengers and crew members have been killed in addition to persons on the ground. Over-all, there have been 103 aviation accidents in the U.S. to date. In domestic scheduled operations, 177 passengers and 35 crew members have been killed as compared with a previous high of 156 passengers in 1955. No pattern of accident causes has been evident, but Federal Aviation Agency is tightening safety enforcement activities during the next 30 days and is stiffening safety inspection of training, line operations, type-rating, transition checks and six-month proficiency checks.

▶Watch for Lufthansa German Airlines to place an order this week for seven Boeing 720-420 medium-range turbojet transports. Carrier now has four Boeing 707 Intercontinental turbojets on order. Desire to operate a single family of aircraft in its fleet is believed to have tipped the scales in favor of Boeing over the Convair 600.

▶Chicago Helicopter Airways is considering the purchase of two Sikorsky S-58s to add to its fleet of six already on order as a result of increasing passenger traffic. The carrier also may revise its tentative plans to phase out its S-58s as the six S-61 turbine helicopters on order are delivered in 1961-62 and seek to expand its routes to include more Chicago suburbs, Milwaukee, Indianapolis and Detroit. CHA now projects increases in total passengers carried annually to 330,000 in 1960, 500,000 in 1961 and 1 million in 1962 when the six S-61s are in full service.

▶Lake Central Airlines has completed an engineering evaluation of a Convair 340 powered by Allison 501 turboprop engines. Although operations officials of the airline were impressed with the Convair's performance over Lake Central routes, the carrier is not expected to launch a re-equipment program in the foreseeable future. At the recent Assn. of Local Transport Airlines' meeting in Indianapolis (AW Nov. 23, p. 45), Lake Central Executive Committee Chairman Dr. R. B. Stewart emphasized that prospects for converting to turbine power were dim and said that " . . . we just can't equip at these costs."

▶British European Airways' load factor on its London-Moscow route has dropped from a summer peak of 65% to a current 25%. To stimulate traffic, the airline will introduce tourist round trip fares of $238—28% less than present fares.

▶Initial talks on pooling of airline ground equipment and facilities at major airports have been conducted within the Air Transport Assn. Purchasing Committee, but most observers believe that first pooling agreements will be worked out bilaterally—similar to the present agreement between Air France and TWA rather than on an industrywide scale.

▶Russian-backed Council for Mutual Economic Assistance's permanent working group on air transportation has conducted a Moscow meeting of Communist-bloc nations to discuss recommendations for standardizing jet-age flight rules, communications and control tower procedures. Need for new and modernized commercial airports in eastern Europe also was reviewed at the session which was attended by representatives from Bulgaria, Hungary, East Germany, Rumania, Poland, Czechoslovakia and the USSR. Delegates from Red China and Outer Mongolia were present as observers.

▶Potez Air-Fouga, French aircraft firm, is developing a four-engine transport designed to carry 20-25 passengers. Aircraft, which is being developed without government support, is expected to fly sometime next year. Plane will be powered by 450 hp. Turbomeca Astazou turboprops.

▶Venezuela and U.S. delegations met last week in Washington to begin talks on the bilateral air transport agreement between the two countries. Primary purpose of the sessions is to resolve problems arising from the forthcoming introduction of turbojet equipment on Venezuela-U.S. routes.

SHORTLINES

▶**British Overseas Airways Corp.** plans to extend its de Havilland Comet 4 jet transport service to the Caribbean area in February. Initially, BOAC plans six Comet 4 flights per week from New York to Montego Bay, Jamaica, with three flights on a nonstop basis and three others stopping at Nassau, Bahamas. The airline reports that the Comet 4s now in service over its North Atlantic routes are carrying near-capacity loads. Flights on the London-New York route, BOAC says, are running up to 96% of capacity; London-Montreal flights up to 95%.

▶**Communist China** plans to increase its airline network to at least 46,575 mi. by 1962, last year of the nation's second five-year plan. Present network is over 22,356 mi. Peking now has regular air connections with more than 70 domestic and foreign cities.

▶**France's around-the-world service,** first reported by AVIATION WEEK (AW Nov. 9, p. 50), is scheduled to begin May 10 when Transports Aeriens Intercontinentaux extends its service from Bora Bora in the South Pacific to Honolulu and Los Angeles. The new service will link with Air France flights eastward from Los Angeles as far as Saigon, South Vietnam, where it will connect with TAI's South Pacific operations.

▶**Pan American World Airways** is planning to incorporate Chinese-speaking stewardesses on its routes from the U.S. to Tokyo and Hong Kong. Applicants must be able to speak conversational Cantonese as well as English. Pan American has been using stewardesses conversant in Japanese on its Japanese flights for the past several years.

▶**Sabena Belgian World Airlines** is manufacturing seven 36-seat sets of an airliner seat designed to absorb high decelerations for Air France. Seats will be used in first-class passenger cabins on Air France's Boeing 707-320 turbojets. U. S. Air Force also is considering using the same type seat. In laboratory tests, resistance of the Sabena-designed seat to deceleration was about 20g.

▶**San Francisco International Airport** reports that 370,275 passengers flew in and out of the airport during October for an increase of 49,097 persons, or 15.3%, over the same period of 1958. The airport handled 3,627,883 lb. of air- and first-class mail during the month, a decrease of 1.8% from last year.

A McDonnell Quail diversionary missile being launched from its B-52 mothership.

On missiles like the Quail, shown just after launching from its B-52 mothership, space and weight are at a strict premium. Equally valuable is the highest degree of reliability in each of its components. And in choosing miniaturized quick-disconnect couplings for the Quail, McDonnell selected Aeroquip 1010 Series Self-Sealing Couplings. They are used in the fuel, lube oil, and pneumatic systems on the Quail, to provide maximum space and weight savings with complete reliability.

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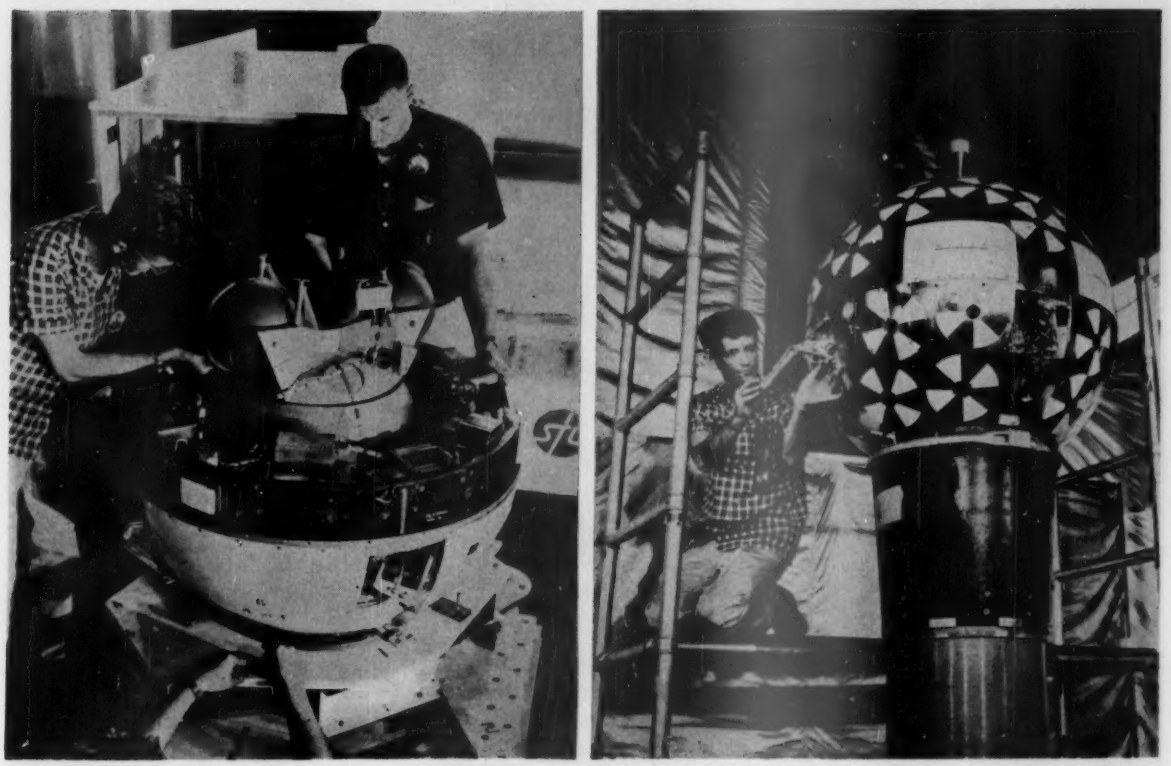


ATLAS-ABLE IV payload, containing 130 lb. of instrumentation on 5-in. shelf inside payload waist (left) is most sophisticated space probe package attempted by U. S. Instrumentation was developed by Space Technology Laboratories. Satellite internal temperature is held to about 70F by 50 four-bladed pinwheels on surface (right), each mounted on a temperature-sensitive coil.

Atlas-Able IV Instrumentation Detailed

Washington — Instrumentation package carried by the recent unsuccessful Atlas-Able IV, the most sophisticated yet attempted (AW Dec. 7, p. 31), was designed to provide more detailed data on the nature of space radiation and magnetic fields in the vicinity of the earth, the moon and the space between.

Correlation of radiation data obtained from early satellites, fragmentary because of payload limitations, has been difficult because measurements were made at different times, altitudes and locations. By combining several different types of radiation sensors into a single payload, together with sensors to measure magnetic field strength and direction and satellite aspect angle relative to the sun, scientists hoped to obtain important new insight into the environment of space.

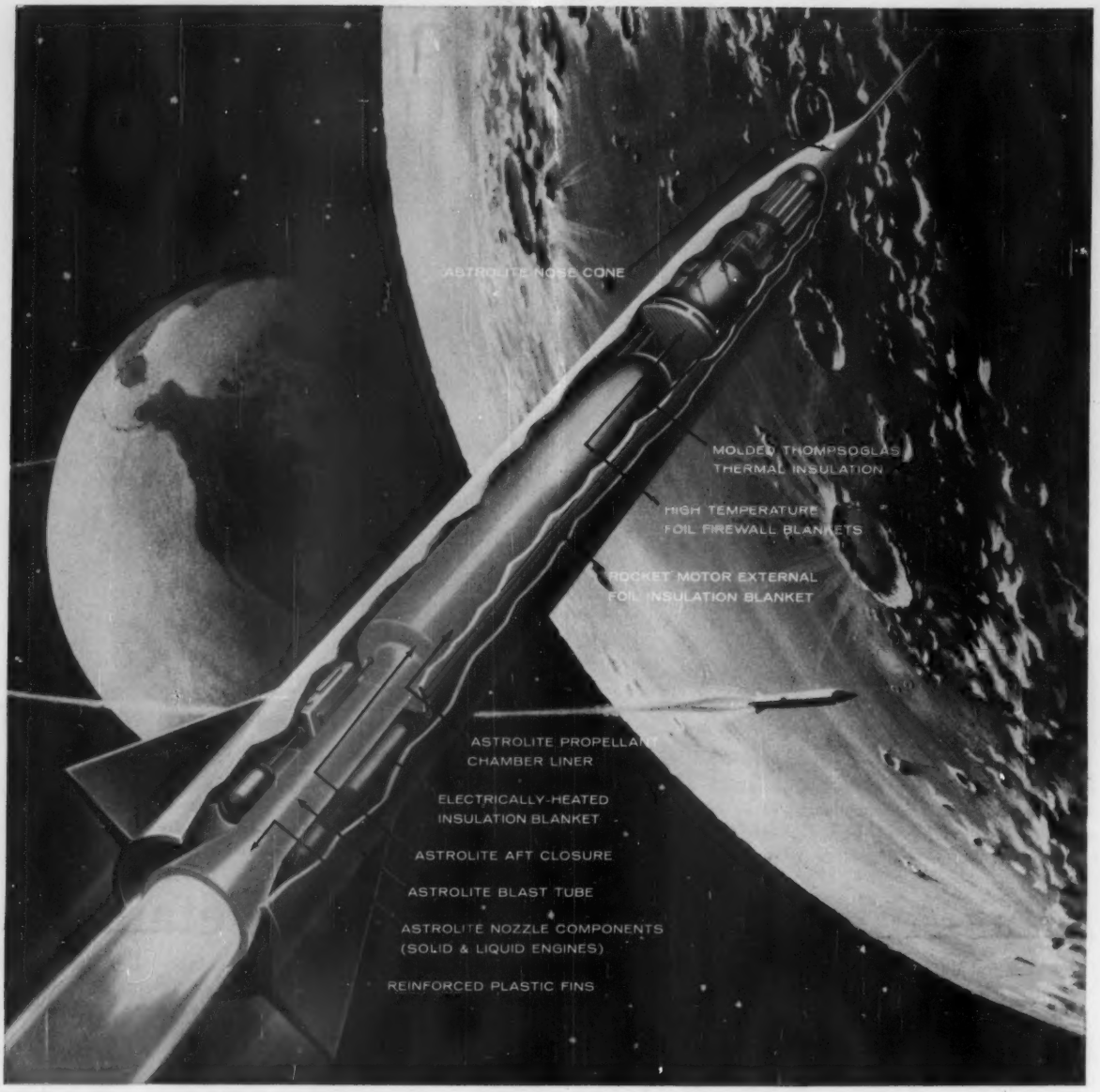
Atlas-Able IV instrumentation designed to measure radiation included:

• **High-energy radiation counter** developed by the University of Chicago was designed to measure "hard" radiation, consisting of electrons with energies greater than 12 million electron volts (MEV) or protons with energies above 70 MEV. The device, called a "proportional counter telescope," was intended to measure the high-energy radiation trapped in the earth's magnetic field as well as high-intensity radiation coming from the sun. The 5-lb. device consisted of a cluster of six argon-gas-filled cylinders surrounding a seventh cylinder. The entire bundle, surrounded by a thin lead shield, measured approximately two inches square. High-energy radiation particles penetrating the lead shield and any one of the cylinders ionizes the argon gas, producing an electric pulse. If the particle is of extremely high energy, it also will pass into the center cylinder and possibly into the counter on the opposite side. The number of counters penetrated is a measure of the particle energy. The six outer counters were connected in a group of three to also permit the device to register three simultaneous penetrations (triple coincidence) in the presence of high flux density.

• **Total radiation flux counter** developed by the University of Minnesota consisted of an ionization chamber and a Geiger-Mueller tube which are sensitive to medium-energy radiation. This two-pound unit was intended to measure the over-all radiation changes and the energy levels of cosmic rays from the sun as well as changes occurring during sunspot activity. The ion chamber, consisting of a three-inch metal ball filled with argon gas, was an integrating type. The halogen Geiger-Mueller counter was similar to those carried by the Pioneer III and IV and on the Explorer VI.

• **Scintillation counter** developed by Space Tchnology Laboratories, Inc., was intended to measure extremely low-energy radiation. The three-pound device consisted of a plastic cylinder 2½ cm. in diameter and a photomultiplier tube. Radiation passing through the plastic produces a small burst of light whose intensity is measured by the photomultiplier and converted into an electrical signal.

Because magnetic fields can trap or deflect radiation particles, scientists expect magnetic field instrumentation to shed additional light on the nature of radiation and vice versa. The Atlas-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ATLAS-ABLE IV vehicle is launched at Cape Canaveral, Fla.

Able IV payload included the following instruments for measuring magnetic fields:

• **Flux-gate magnetometer** developed by Space Technology Laboratories was designed to measure magnetic fields of the earth and the moon along one axis of the satellite. Device weighed 2¼ lb.

• **Search-coil magnetometer,** also developed by STL, employed a sensor consisting of a mu-metal core and 5,000 turns of fine copper wire. The one-pound device measured the strength of the magnetic field entering the middle of the satellite.

• **Aspect indicator** consisting of a small photocell provides a signal which indicates satellite angle relative to the sun.

Combination of data from the two types of magnetometers, when correlated with information on the solar aspect angle of the satellite, was expected to show the strength, direction and distribution of magnetic fields in space.

The Atlas-Able IV also carried a 2¼ lb. scanning device, a crude form of television camera, intended to provide a dark-and-light reproduction of the moon and earth's surface. The device, identical to the camera used on Explorer VI to transmit back a cloud-cover picture of the Central Pacific, consists of a mirror in a metal tube which focuses light and dark impressions on a photoelectric device. As the satellite spins at 2½ revolutions per second, a series of light intensity signals is produced that can be transmitted back to earth, recorded on magnetic tape and subsequently used to produce a crude picture. Each signal produces a light or dark dot, with a total of 128 dots forming a horizontal line in the picture.

Radio Receiver

The satellite also was outfitted with a small, extremely sensitive very-low-frequency (VLF) radio receiver built by Stanford University which was intended to receive natural radio waves generated by ionized space gases at a frequency of around 15 kc. The results of this experiment also were expected to provide additional clues on the radiation and magnetic fields found in interplanetary space.

Two small transponders aboard the Atlas-Able IV payload were to provide means for determining electron densities in space by measurement of small time delays in propagation of the signal from the earth to the satellite and back to earth.

All of the instrument data was to be telemetered back by means of the digital Telebit system developed by STL (AW Sept. 14, p. 91). Data accumulated when the satellite was not within range of an earth telemetry station would be stored and the accumulated totals transmitted when earth contact was subsequently established. Following readout of totals, instantaneous readings would then be sent for the remainder of the transmission. The signals from the facsimile camera were to be transmitted continuously.

UHF Transmitters

The satellite carried two five-watt UHF transmitters for telemetry operating at a frequency of 378 mc. The two transmitters were connected so that either could transmit all of the instrument data, providing backup in the event one failed.

The satellite payload, including a provision for initiating 20 different functions such as engine start-stop by means of radio signals, employed more than 2,500 transistors and 3,500 diodes. Total weight of instruments, telemetry

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***Target location:** through navigational aids so accurate that conventional warheads may be used on concentrated targets with a high probability of success.

***Data Handling:** to interpret and relay the target data from TI-equipped drones and snooper aircraft to the field commander in useable form.

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For detailed discussion of TI Surveillance hardware, currently in production for the USAF and US Army Signal Corps — cleared personnel "with need to know" are urged to call or write: SERVICE ENGINEERING DEPT.

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APPARATUS DIVISION

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equipment and power supply was 121 lb.

Electric power for the payload was to be supplied by nickel cadmium batteries charged by 8,800 silicon solar cells, 10% more than the number carried on Explorer VI. These were mounted on four paddlewheels similar to the ones used on Explorer VI. Paddlewheels were folded during launch with springs to erect them after second-stage burnout. Solar cells could supply a maximum of 66 watts power in direct sunlight.

A novel method was employed to maintain temperature of the instrument compartment at approximately 70F while the temperature of the paddlewheels might vary from minus 200F to plus 200F. Developed by STL, the new technique employed 52 four-bladed pinwheel-type devices located around the surface of the satellite skin. Each pinwheel was mounted on a temperature-sensitive coil in such a manner that changes in temperature of the coil would cause the pinwheel to rotate slightly. The circular area of satellite skin underneath the pinwheel was coated with alternate patches of dark material which absorbed sunlight and white material which reflected sunlight.

When the internal satellite temperature increased, it would have caused the coil to rotate the pinwheel blades so as to cover the dark (heat-absorbing) area and expose the light reflecting area. When the temperature dropped, the pinwheel would rotate in an opposite direction so that its blades covered the reflecting surface and exposed the absorbing surface to sunlight. Each pinwheel-coil combination operated independently to provide temperature control of its local area.

More than 50 scientific and industrial firms participated in the program under the technical direction of Space Technology Laboratories. Principal subcontractors, in addition to those mentioned, included Engineered Magnetics, Gilfillan Bros., Hallamore Electronics, Motorola, Radiation, Inc., Rantec, Inc., and Space Electronics Corp.

Air Force Establishes Satellite Test Wing

Washington—Air Force has established its first satellite test wing with the formation of the 659th Test Wing at Palo Alto, Calif., to handle launch, tracking and recovery phases of the Project Discoverer program.

New test wing is responsible to the Air Force Ballistic Missile Division and includes the instrumentation and test squadrons stationed in Hawaii which have been participating in Discoverer recovery attempts.

NASA Asks Patent Rule Change, Proposes More Flexible Policy

Washington—Repeal of the controversial patent provisions in the 1958 Space Act and substitution of a more flexible set of rules is being recommended to the Patent Subcommittee of the House Committee on Science and Astronautics.

Revision of the patent provisions, which have been under attack by contractors since the law was enacted, was proposed by John A. Johnson, general counsel of the National Aeronautics and Space Administration, and supported by other government agencies and industry representatives.

Under the present law, inventions or discoveries made in connection with space work become the exclusive property of the government unless waived under certain conditions by NASA. The law was patterned after, and is similar to, the patent provisions of the Atomic Energy Commission.

Johnson told the subcommittee that a more useful plan would be to pattern the legislation after the National Science Foundation provisions which would permit NASA to adopt policies and practices suited to fit its particular needs. He recommended that this language be substituted for the current provisions:

- "**Each contract** or other arrangement entered into by the Administration, and each subcontract at all tiers thereunder, which has as one of its purposes the performance of experimental, developmental or research work, shall contain provisions prescribed by the administrator governing the disposition of the rights to inventions conceived or first actually reduced to practice thereunder in a manner calculated to protect the public interest and the equities of the contractor.
- "The **administrator** or his designee may, whenever the contract provides for the vesting of title to an invention in the U. S., waive the rights of the U. S. to such invention on such terms and conditions as he determines to be in the best interest of the U. S.: Provided that any such waiver shall be subject to the reservation of an irrevocable, nonexclusive, nontransferable, royalty-free license for the practice of such invention throughout the world by or on behalf of the U. S. or any foreign government pursuant to any treaty or agreement with the U. S.
- "**The administrator** may waive, upon the same terms as provided (the section above) . . . all or any part of the rights of the U. S. to inventions made in the performance of any work under any contract heretofore entered into by or for the Administration which have become the exclusive property of the U. S. Any contract heretofore entered into by or for the Administration on which final payment has not been made may be amended without consideration to effectuate the purposes of this section: Provided that no such amendment shall affect the status of inventions which have become the exclusive property of the U. S.
- "**The Administration** shall be considered a defense agency of the U. S. for the purposes of the Inventions Secrecy Act, Chapter 17 of Title 35 of the U. S. Code."

"Requirements of good government," Johnson said, "call for giving NASA greater flexibility so as to eliminate in-

Transit Satellite Schedule

Washington—Series of Navy Transit navigation satellites now scheduled include these projects:

- **Transit 1A—Scheduled to be fired before the end of the year. This will use a three-stage Thor-Able vehicle.**
- **Transit 1B—Scheduled for launch in or around March, 1960. Vehicle will be the two-stage Thor-Able Star, a Thor booster coupled to the AJ10-104, a new version of the Aerojet AJ10-101A Vanguard engine used in Explorer VI. The -104 engine will have a single chamber developing approximately the same thrust as the -101A but will incorporate shutoff and restart capability and will have a greatly extended burning time because the tankage will be about 2½ times larger. Photographic equipment is scheduled to be part of the payload.**
- **Transit 2A—Scheduled for launch in May, 1960. This also will use the Thor-Able Star vehicle, and payload will include photographic capability. This project is scheduled to take the place of Army Signal Corps Courier 1B, a delayed repeater communications satellite. Army's Courier 1A project, which also uses a Thor-Able Star vehicle, remains unaffected and is scheduled for launch about June, 1960.**
- **Transit 2B—Project not completely firm at this time, but it is scheduled to use the Thor-Able Star vehicle.**

FABRICATION TESTS SHOW...

New Titanium alloy takes the

...in strength...in weight...in reliability...in price

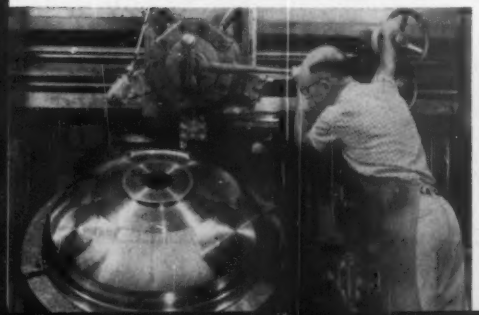
Titanium rocket-motor cases can be built at least 30 percent stronger (or lighter) than best available alternate metals; provide permanent corrosion resistance without protective coatings; withstand temperatures from −400°F to +800°F; will not absorb moisture which distorts critical parts in storage.

Completed assemblies give a spectacular two-way pay-off . . . immediately; provide a growth potential virtually unlimited.

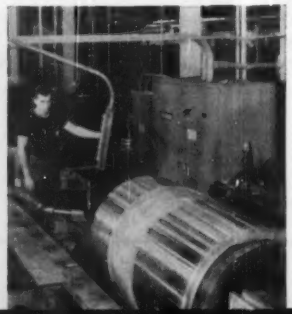
The alloy: Ti-13V-11Cr-3Al, the beta titanium alloy. Now available from Titanium Metals Corporation of America at commercial lead-times (billet, 2-3 weeks), beta may well become the metals story of the year.

Welding of titanium at P&WA is based on the company's experience in production of more than 5800 jet engines containing titanium parts. Weld strength of beta titanium alloy is considerably improved by cold working the weld.

End Closure Titanium Forgings produced by Wyman-Gordon Company and machined by P & WA, will be *girth welded* to the flow-turned cylinders. Bosses are an integral part of the closures.



Flow-turning from roll-forged rings, makes feasible production of full-scale titanium rocket cases, since it yields integral cylinders, eliminates need for longitudinal welds, conserves input metal.



Pilot rocket-motor cases manufactured by Pratt & Whitney Aircraft from beta titanium alloy Ti-13V-11Cr-3Al have been consistently burst-tested at levels in excess of 235,000 psi – a burst strength/density ratio of 1,340,000.

So successful has been its titanium program that Pratt & Whitney Aircraft considers that production of full-scale titanium cases can be easily realized. Estimated initial burst strengths: a conservative 180,000 psi – a burst strength/density ratio of 1,000,000. Readily attainable: 1,250,000.

Reasons for optimism, spelled out by P&WA's engineers are:

1. **"The welded beta titanium alloy is capable of considerable plastic deformation prior to rupture. As welding has improved, the failure origins have moved into the thin wall (of the case itself). With beta titanium, the case tears, but doesn't fragment.**

2. "We have successfully tested small scale titanium cases with a steel equivalent yield strength well beyond the 300,000 psi point. Considering that the metallurgy of metastable beta titanium alloys is not far beyond its infancy, conservatively one would predict strengths substantially higher than the 320,000 psi equivalent as being quite possible.

3. **"Beta titanium has to develop (only) 140,000 psi to be equivalent to 220,000 psi steel (which is almost near steel's top limits). But titanium's great potential above other alloys is reflected in the high figure for practical (based on 5% elongation) yield strength. At 180,000 beta titanium is equivalent to steel at 280,000 psi; at 200,000 psi, beta titanium is equivalent to steel at 320,000 psi. 200,000 psi in beta titanium is possible, and obviously would mean substantially increased payload to the moon or out into space.**

4. "Apart from the strengths attainable in the beta titanium alloy, there is another property of considerable significance. Like other titanium alloys, it has excellent resistance to corrosion under normal atmospheric conditions, in salt water as well as in many other media.

"In considering the long time storage problems with rocket cases – a pit in a thin-walled casing can be catastrophic – we would regard the beta titanium alloy, as the outstanding material under consideration."

lead in rocket case construction

PRATT & WHITNEY AIRCRAFT SURVEY OF ROCKET CASE MATERIALS

GENERAL PROGRAM

The goal: "A material capable of reaching 300,000 psi yield strength in steel, with a considerable development margin."

The result: "While this goal had to be modified for steel cases, we have successfully tested small scale titanium cases with a steel equivalent yield strength w ''l beyond the 300,000 psi point."

Conclusions: 1. "By exercising reasonable care, the development of full scale (steel) cases at 240,000 psi is perfectly feasible.

2. "Small scale (titanium) cases have been burst at stress levels as high as 260,000 psi . . . we are convinced that reliable cases can be manufactured (from titanium) at yield strength levels of 180,000 psi and over . . . at 180,000 beta titanium is equivalent to steel at 280,000 psi.

"At 200,000 psi beta is equivalent to steel at 320,000 psi. 200,000 psi beta is possible and obviously would mean substantially increased payload to the moon or out into space."

SPECIFIC COMPARISON: Corrosion Resistance

Steel: "All of the low-alloy constructional steels which have been discussed are subject to general rusting and, far more serious, to pitting type corrosion during machining, welding, heat treatment, pressure testing and final storage. Corrosion pits can act as severe stress-raisers and, in conjunction with hydrogen, have been demonstrated to cause catastrophic failure. It therefore goes without saying that pitting corrosion is a serious hazard."

Titanium: "Like other titanium alloys, the beta titanium alloy has excellent resistance to corrosion under normal atmospheric conditions, in salt water as well as in many other media.

"In considering the long-time storage problems with rocket cases—a pit in a thin-walled casing can be catastrophic – we would regard the beta titanium alloy as the outstanding material under consideration."

SPECIFIC COMPARISON: Strength

Alloy	Density	Practical Yield Strength (5% elongation)
Ti-6Al-4V	0.161#/in.³	155 ksi = steel at 270 ksi
Ti-13V-11Cr-3Al (Beta)	0.175#/in.³	180 ksi = steel at 280 ksi
		190 ksi = steel at 305 ksi
		200 ksi = steel at 320 ksi

Burst Test Results show titanium has provided consistent burst strengths of 235,000 psi – a burst strength/density ratio of 1,340,000. Failure occurs in the wall of the case itself – not the weld zones. Titanium cases do not fragment.

• Reliability and growth . . . the parallel

Pratt & Whitney Aircraft data reveal rocket-cases can *now* be built from beta titanium at strengths 17 percent greater than alternate metals, with beta titanium's strengths bounding forward under a minimum of development.

A striking parallel exists in liquid-fueled rocketry where titanium alloy Ti-6Al-4V was selected for helium storage bottles in the Atlas missile because of its strength/density ratio. Airite Products, Inc., a leading supplier of the titanium vessels, reports:

"Minor modifications in processing techniques and continuous tightening of tolerances and other variables have shown an increase from the original 5400 psig average burst pressure to the present average which is in excess of 9000 psig.

"This has been done without increasing the weight of the article by one ounce. Weight of the unit, incidentally is controlled to a tolerance of plus or minus one-half pound, on a weight of 79 pounds, and volume is controlled and guaranteed to plus or minus one percent."

While the performance of the titanium pressure vessels has been almost doubled, the price has been reduced almost 50 percent – and the missile has become operational.

• When a case fails, so does the missile

The price of completed beta titanium rocket-cases is now estimated at 2½ times the price of other metals, with titanium cases virtually in their infancy. Should the titanium cost difference remain, the pay-off would still be two-fold:

1. **Cost:** engineering time, would be greatly curtailed; expensive fuels (for example, 30 pounds of fuel are required in earlier stages for each additional third-stage pound) would be saved.

2. **Reliability:** titanium cases simply will not pit, rust, deliquesce, or become hydrogen embrittled.

Added together, these elements mean feasibility—feasibility supported by the commercial availability of the metal itself. Beta titanium alloy Ti-13V-11Cr-3Al is available from Titanium Metals Corporation of America at these lead times: billet, 2-3 weeks; bar, 3-4 weeks; flat-roll, 5-6 weeks. TMCA's metallurgical experience with the alloy is yours for the asking.

For further information, write for TMCA Data Bulletin *All-Beta Titanium for Solid Rocket Pressure Chambers.* Extensive welding information is included.

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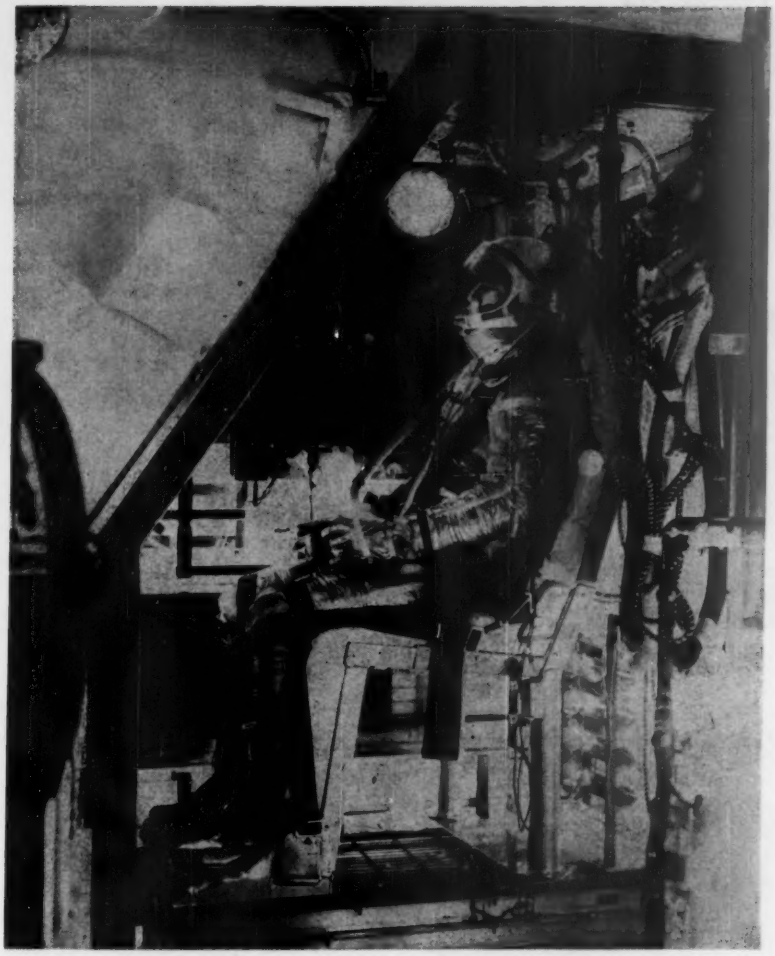

Re-Entry Simulated in Mercury Full-Pressure Suit

Wearing Project Mercury full-pressure suit, M. Scott Carpenter is subjected to simulated re-entry in heat-pressure chamber at Navy Air Crew Equipment Laboratory, Philadelphia. Suit is pressurized to 5 psi.; chamber simulates 60,000 ft. altitude. Suit is being developed by Navy, NASA's Space Task Group and Goodrich Tire and Rubber Co.

equities to contractors, lighten its own administrative burden and minimize contractor opposition, all of which, in our opinion, will serve the best interests of the National Space Program."

What Plan Would Do

Johnson said the proposed language would authorize NASA to do the following:

• **Adopt contractual provisions** governing the disposition of rights to inventions conceived or reduced to practice in the performance of experimental, developmental or research work. NASA could contract to take title to the invention or permit the inventor to retain title, whichever would best protect the public interest and the contractors.

• **Waive the rights** of the U. S., if it would serve its best interests, even if the contract calls for the U. S. to take title to an invention. The U. S., however, would reserve a royalty-free license to use the invention anywhere in the world.

• **Contracts already made** could be amended to conform with the new provisions if final payment had not been made.

However, inventions which already had become the exclusive property of the U. S. would not be affected.

Johnson said that, while the present law permits the NASA administrator to waive all or part of the government's rights to inventions, the emphasis is on taking title, which prevents NASA from contracting for lesser rights in inventions made by contractors where the interests of the government do not require acquisition of title.

Another problem, Johnson told the subcommittee, is that most of NASA's contractors are from the same segments of industry that do most of their contracting with the Defense Department. In most cases, he said, the same tech-

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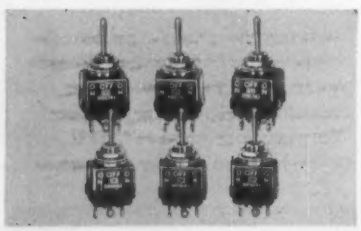

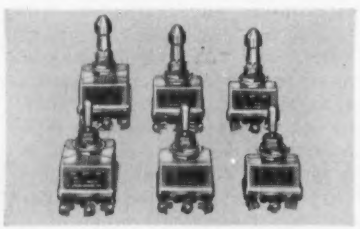

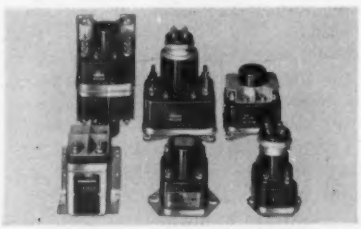

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Cutler-Hammer Inc., Milwaukee, Wis. • *Division:* **Airborne Instruments Laboratory.** • *Subsidiary:* **Cutler-Hammer International, C. A.**

Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation.

nology also forms the basis for both NASA and Defense Department contracts, and programs are often jointly sponsored.

Since NASA practice required under the present law differs from that of the Defense Department, Johnson said the disposition of patent rights in inventions under contracts that are basically similar and often with the same contractors may depend solely upon whether the source of funds is NASA or Defense Department appropriations.

The NASA general counsel said NASA feels "that the government ought to deal equally, regardless of the agency involved, with contractors engaged in substantially similar work. It is therefore necessary, to assure itself of the continuing willingness of contractors to participate in projects of great national importance, that NASA be given discretionary authority to adopt contractual patent provisions in line with the Defense Department where necessary to meet the equities of the situation."

Johnson added that the proposed legislation also would enable NASA to adopt patent provisions in its contracts identical with those of the AEC in cases where the production or utilization of special nuclear material or atomic energy is involved. The AEC act provides that inventions made under contract and involving nuclear material or atomic energy will be regarded as having been made by AEC.

Other Witnesses

Other witnesses appearing before the subcommittee included:

• **James P. Falvey,** deputy assistant secretary of defense for supply and logistics, who said Defense supports the proposed amendment to NASA's statutory patent policy.

• **James P. Burns,** chairman of the Government Patent Policy Study Committee of the National Council of Patent Law Assns., who said acceptance of NASA's proposed changes, until a uniform government policy can be formulated, will make research in the space field more attractive to private industry and help preserve the normal functioning of the patent system.

• **Charles L. Shelton,** United Aircraft Corp.'s patent section, who testified on behalf of Aerospace Industries Assn., saying the patent provisions of NASA are radically different from any provisions previously used in government contracts in the aeronautical and related fields. He asked that NASA be given the same privileges as the Defense Department to issue regulations that can meet the needs of government and, at the same time, protect the public interest and the interests of contractors and subcontractors.

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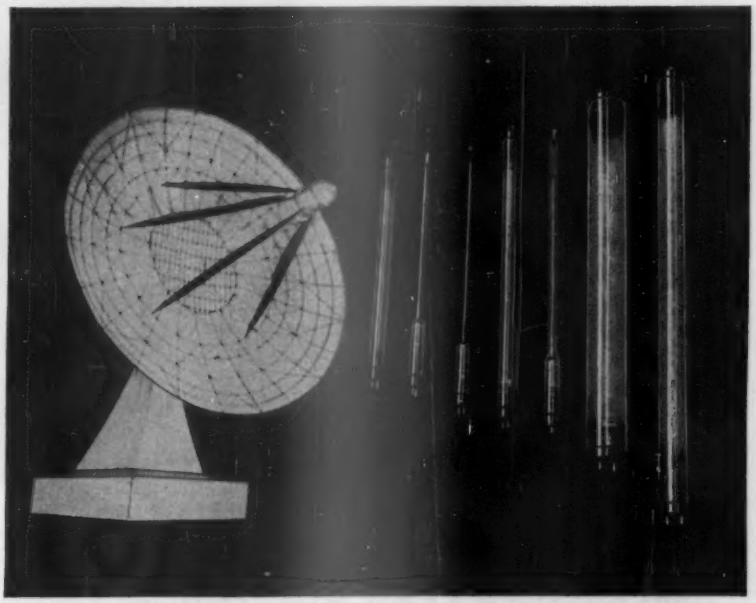

Complete engineering data on the Bendix Microwave Noise Source Tube line and on auxiliary circuit designs can be obtained by writing . . .

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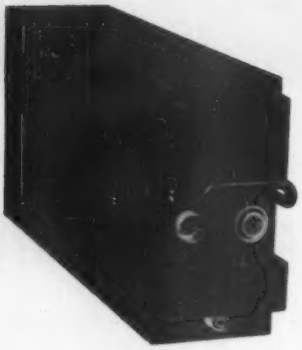

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NASA Urges Project Echo Participation

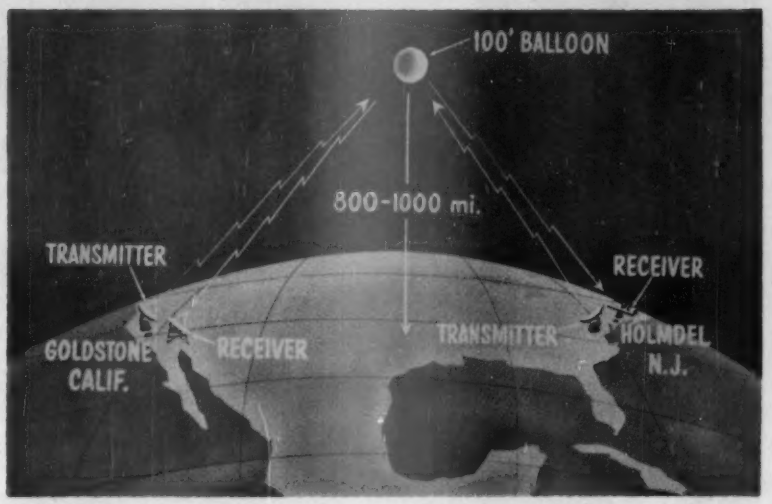
Washington—Industry, scientific organizations and private experimenters are being encouraged by the National Aeronautics and Space Administration to participate on a voluntary basis in Project Echo, the agency's first experiments with a passive communication satellite.

First of three 100-ft. diameter spheres will be launched this spring from the Atlantic Missile Range. Objective will be a 900-mi.-high circular orbit traversing the earth between approximately 50 deg. north and south latitudes.

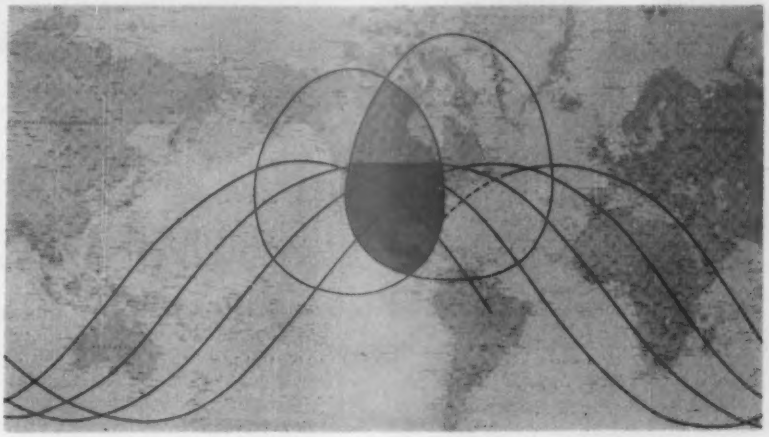
Full details on the NASA experiments as now planned are contained in a recently issued report by NASA. Interested experimenters with suitable receivers and antennas will be free to tune in on signals bounced between NASA Jet Propulsion Laboratory facility at Goldstone, Calif., and a Bell Telephone Laboratories facility at Holmdel, N. J.

A frequency of 2,390 mc. will be used for west-to-east transmission and a frequency of 960 mc. will be used for east-to-west transmission. A receive-only station also will be operated by the Naval Research Laboratory at Stump Neck, Md.

Experimenters who have facilities to attempt to transmit their own signals are asked to notify Leonard Jaffe, NASA in Washington, to prevent interference between experimenters.



NASA'S Project Echo passive communication satellite experiments will use ground stations in California and New Jersey. Private experimenters also are encouraged to participate.



PRESENT plan calls for placing 100-ft. diameter sphere in a 50-deg. inclined, 900-mi. high circular orbit, providing communication relay coverage of the area shown.

Launch Time

Satellite launch time will be selected to permit the first passes over the U. S. to occur during the twilight hours so that optical tracking can be used to establish accurate ephemeris (orbit predictions). Third-stage rocket will carry a radio beacon operating at 108.00 mc. to aid in locating the satellite during its initial passes when the third stage is near the satellite. NASA says two small beacons operating at 107.94 mc. and 107.97 mc. are being developed by Radio Corp. of America in the hope that they can be attached to the inflated sphere itself without damage to the sphere.

The launching vehicle will be a Delta rocket consisting of a Thor first stage, an Able (Vanguard) second stage and an Allegany Ballistic Laboratory solid-propellant third stage.

Two antennas, one for transmitting and one for receiving, will be in operation at both Goldstone and Holmdel. At Goldstone, the 2,390 mc. transmitting antenna will employ an 85-ft. diameter dish with the ability to move in azimuth and elevation. Receiving antenna operating at 960 mc. will employ an 85-ft. dish with equatorial mounting.

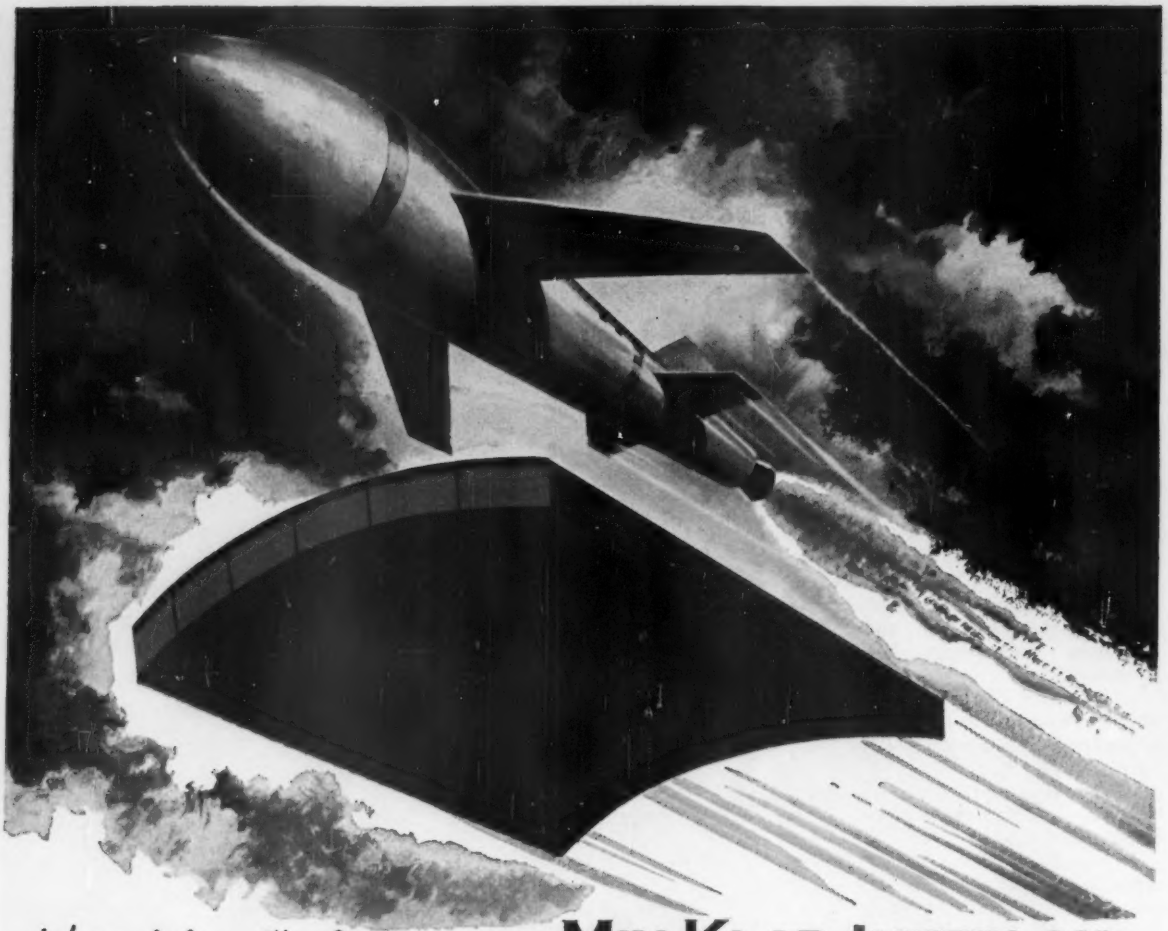
At Holmdel, Bell Laboratories will employ a 60-ft. azimuth-elevation mounted paraboloid antenna for transmitting at 960 mc. and a special horn reflector, equivalent to a 28-ft. paraboloid in terms of gain, for receiving at 2,390 mc. The antenna will be equipped with master amplifiers.

The antennas will be aimed at the anticipated position of the satellite as calculated by the NASA Goddard Space Flight Center near Washington working from optical and beacon tracking data received during the first two passes. Data on satellite position will be transmitted in digital form via landlines to Goldstone and Holmdel where it will be used to automatically position the receiving antennas. Each transmitting antenna will be "slaved" to the receiving antenna so that it will be aimed at the same spot in the sky. The 60-ft. NRL antenna also will be aimed by means of data received from Goddard's computing center.

Self-Tracking System

Once the satellite has been acquired, the transmitter and receiver can be employed as a self-tracking radar system with the antennas positioning themselves for maximum signal return.

The initial experiment will employ continuous-wave transmission to permit a check on the accuracy of the initial Goddard center ephemeris predictions. Following this, voice transmission using frequency modulation will

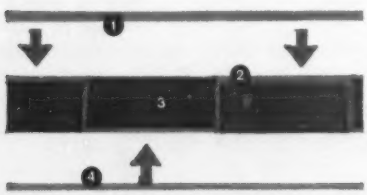


Johns-Manville Announces... MIN-KLAD INTERLOK

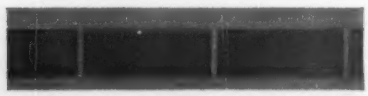
. . . a new structural system interlocking Min-K insulation and high-temperature reinforced plastic

Missile experience shows that in certain heat control situations no one material will perform as well as two (or more)—*an insulation with protective high-temperature facings.*

Problem is how to effectively combine these materials into a structurally strong unit? The answer is Min-Klad Interlok—a new structural system that interlocks Min-K insulation and reinforced plastic, metal or other high-temperature facings.



1) Outer facing, 2) Interlocking web, 3) Core, any one of several Min-K formulations, and 4) Inner facing.



All the above components combine to provide a custom-made structural strong insulating system.

The result: one product that gives the missile designer every advantage of high-temperature plastic or metal foil—strength, toughness, rigidity! Erosion resistance! High heat capacity!

. . . plus the outstanding advantages of Min-K insulation—an insulating core that has the lowest thermal conductivity available for service temperatures up to 2000°F steady-state, and higher for transients. Min-K's thermal conductivity is actually lower than the molecular conductivity of still air.

Wide range of facings

For the hot face, the missile designer can specify Min-Klad Interlok in a wide variety of heat-resistant and/or ablating materials—asbestos-phenolic (ARP-40), and similar reinforced plastics, as well as stainless steel and other heat-resistant metal foils and meshes. For some requirements, the cool face can be made of a different material—for example, one that offers characteristics required for bonding or fastening to other surfaces and parts.

Like all J-M Aviation insulations, Min-Klad Interlok is factory-fabricated to your specifications into external skin panels, heat shields, cylindrical liners or component housings of any shape or size. Write today for technical specifications. Address Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

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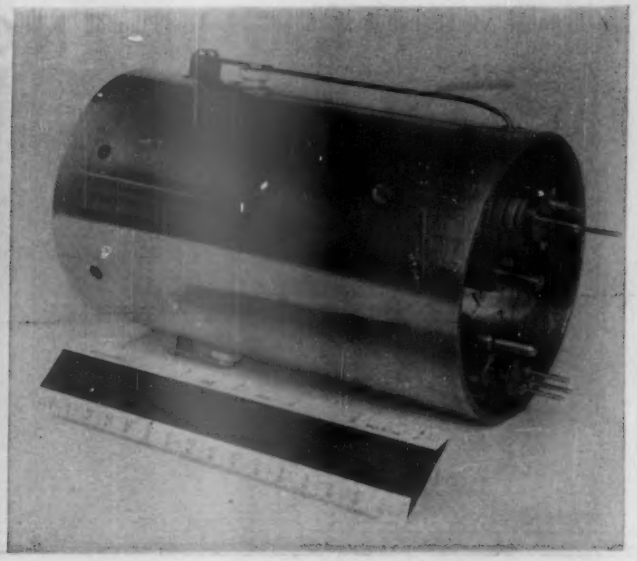


Satellite Power Source, Ion Engine

Ferroelectric converter (left), unit designed to produce high voltage for satellites from sun's rays or other heat sources, has been developed by International Telephone & Telegraph Corp. Converter relies on temperature changes alone. Mockup is shown under simulated solar-heat conditions; dark sections of ceramic coating provides high voltage a.c. current. At right is prototype of a 2 millipound thrust ion engine for satellite vernier control, developed by Electro-Optical Systems, Inc. Propellant source is cesium.

be made to demonstrate the wideband potentialities of a passive communications satellite. Then experimenters will return to CW transmissions to investigate such things as signal scintillation, Faraday rotation of signal polarization and fading.

If the 900-mi.-high orbit is achieved, giving an orbit period of about two hours, the satellite will be visible to both the Goldstone and Holmdel stations during any single pass for an interval that varies from 0-16 min.

With an average transmitter power of 10 kw. at both stations, NASA scientists calculate that the received signal level at 960 mc. will range between −112 and −124 dbm. at distances of 1,500 to 3,000 mi. from the satellite.

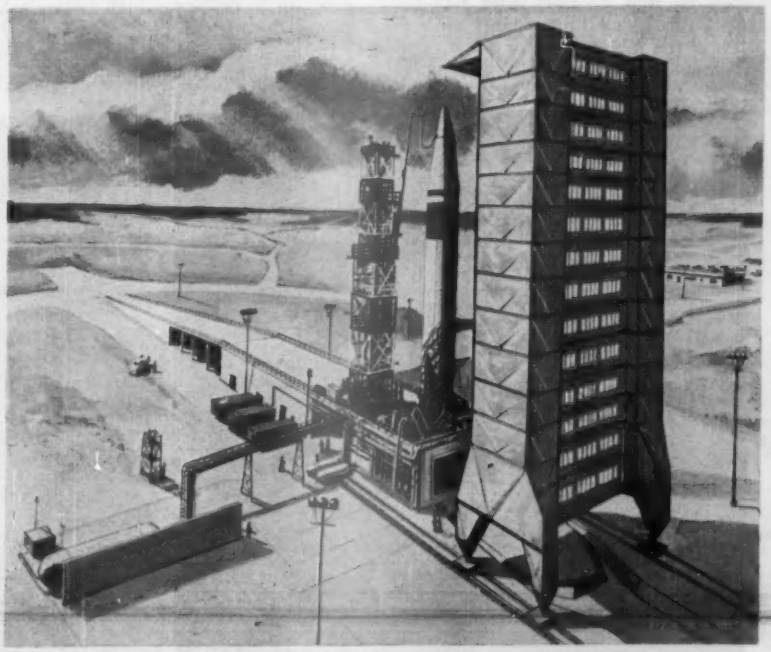
In addition to the communications experiments, Lincoln Laboratories will use its Millstone Hill radar in an attempt to determine the sphericity of the satellite and the propagation characteristics of the sphere at low angles of incidence.

The satellite itself will be fabricated from 82 flat gores of Mylar, 0.0005 in. thick and coated with vapor-deposited aluminum to make it a reflector of radio waves. The satellite is expected to provide reflectivity of 98% or higher for frequencies up to 4,000 mc.

Prior to launch, the deflated sphere will be folded into a 28-in.-diameter container which subsequently will be separated by an explosive charge to release the payload.

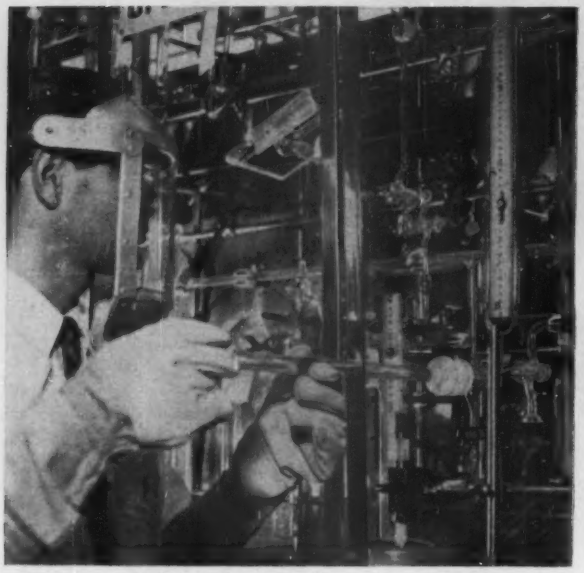
After release, residual air in the folded sphere will cause it to start to expand in the vacuum of space. Two elastic bags inside the sphere will then spray water that will be vaporized by the sun's heat, building up sufficient internal pressure to inflate the sphere. Water pressure will keep the sphere under positive internal pressure. NASA estimates that the sphere should retain its shape despite anticipated micrometeorite damage for at least seven days.

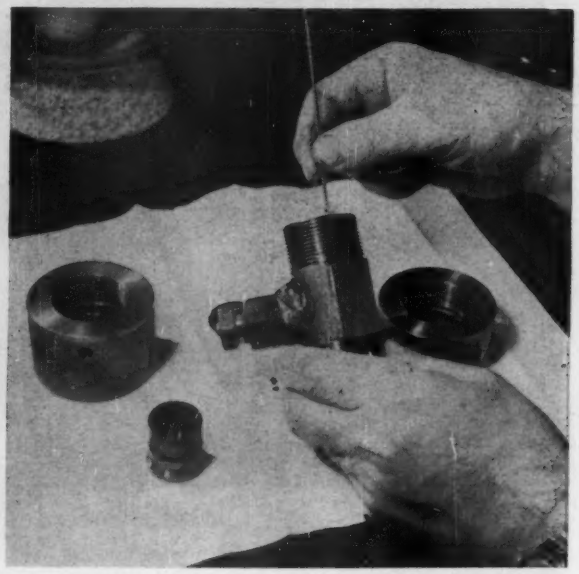
As added insurance the sphere also will contain a sublimating power that will produce a gas to provide additional internal pressure.



Convair Building Vega Launch Pad

Vega space vehicle, 112-ft. high, is shown in this artist's conception of launch complex being built at Cape Canaveral, Fla., by Convair. Gantry is 166-ft. high; complex includes a two-story blockhouse (not shown) and will cost more than $10 million.





FOR SAFETY REASONS, chemist (left) uses long rod with slot in the end to turn stopcock on vacuum rack in which he is synthesizing new propellant material. Disassembled for cleaning, micromotor (right) burns small, 15-gram, solid propellant samples. Small unit at the lower left is the nozzle.

Esso Accelerates Solid Propellant Search

By Michael Yaffee

Linden, N. J.—Scientists at the Esso Research and Engineering Co. here are learning how to work with half-gram quantities of solid propellants while the rest of the rocket industry rapidly works its way toward production of 100,000-lb. solid propellant grains (AW Nov. 23, p. 32). As one of four companies holding integrated research contracts in the Advanced Research Projects Agency's program to develop a high energy solid propellant program (AW Dec. 7, p. 32), Esso has had to devote much time and effort to the development of equipment and techniques for handling extremely small amounts of new, potentially dangerous materials—solids, liquids and gases. The company also has had to blend specialists from all the branches of chemistry—inorganic, analytical, organic, physical and engineering—into a single research unit.

ESSO RESEARCHER (left) focuses movie camera on window in end of a microbomb to record burning behavior of a newly synthesized propellant. Chemist (right) is preparing to compound new material with other propellant ingredients in a V-tube mixing device which will be rotated by remote-controlled rollers.

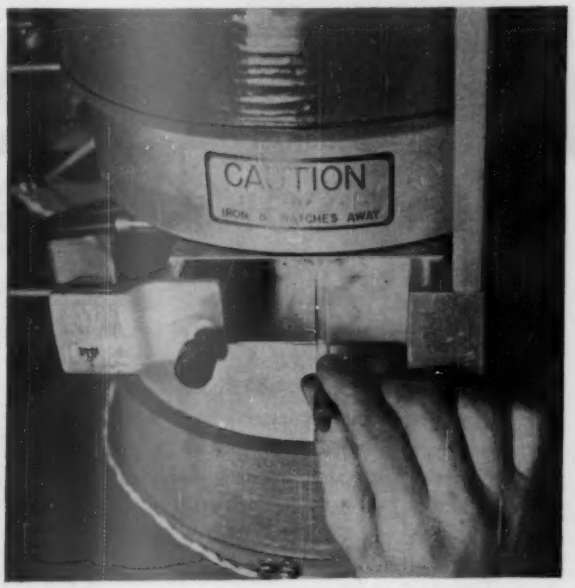
IN THE ANALYTICAL LABORATORY, technician adjusts control knob on panel of vapor fractometer (gas chromatograph) which identifies unknown materials by their characteristic thermal conductivity-time imprint. A hypodermic syringe (right) is used to introduce sample into the chromatograph.

Esso is proving successful in both endeavors. Its original one-year contract was recently renewed by ARPA with approximately a 40% increase in funds. The entire ARPA solid propellant program has proven successful enough to justify extension of original contracts and addition of new ones.

Esso Research and Engineering Co.'s part in the program began Dec. 1, 1958. Its original contract was for $1,264,000, and this has now been renewed for $1,722,000. Actual negotiation and award of the contracts was made for ARPA by Army Ordnance.

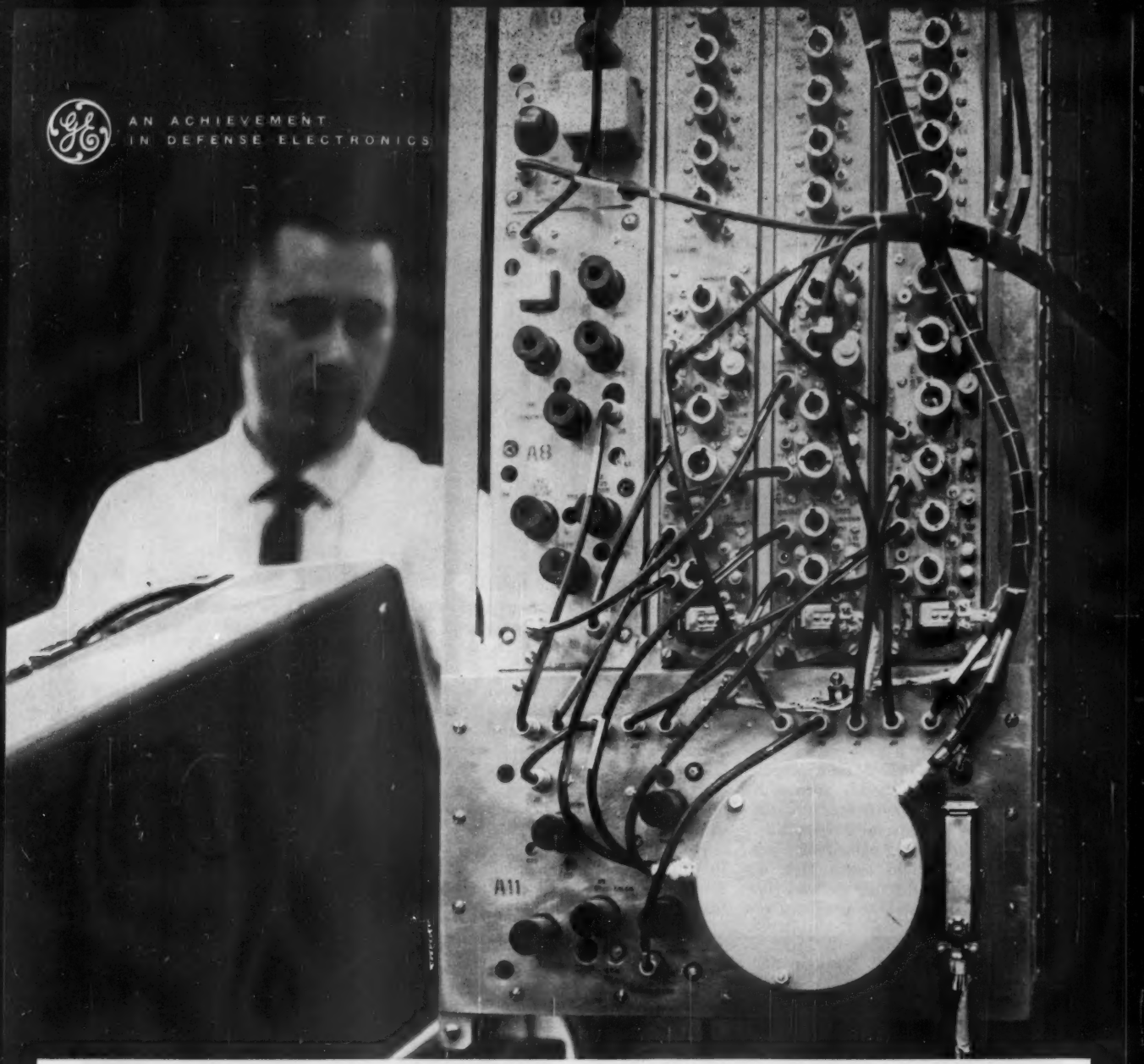
Esso's first move was to set up a Special Projects Unit at its Linden, N. J., Research Center which would operate as a separate group within the company. Dr. John P. Longwell was appointed project director and Dr. John J. Kolfenbach, assistant project director. Directors and staff were chosen from the company to provide a background in all aspects of chemistry.

As soon as the unit was ready to go to work, its first task was to decide, on the basis of thermochemical calculations, what types of chemical compounds it wanted to make. From opposite ends of the electronegative scale, scientists selected a number of elements which, at least theoretically, would combine to form chemical groups (fuels, oxidizers, etc.) that would release large amounts of energy during



ANALYTICAL CHEMIST varies the magnetic field in a Schlumberger nuclear magnetic resonance spectrometer to find resonating ratio which will identify fluorine content of unknown propellant sample. At right, small vial of unknown material is put in place between poles of the large Schlumberger magnet.

AN ACHIEVEMENT
IN DEFENSE ELECTRONICS



NEW SONAR SIGNAL PROCESSOR DOES WORK OF 1,000 UNITS

The first sonar signal processors to utilize time compression are being produced by General Electric. These new processors were developed in cooperation with the United States Navy. Extracting only critical bits of transmitted and received signals in series, one unit can perform as many correlating operations on a continuous signal—in the same time—as a parallel processor with thousands of units.

Excellent improvement in signal-to-noise ratio also makes these new processors effective against background levels which have formerly made certain signals undetectable by any other practical means. The new equipment is also designed to handle signals from more than one transducer.

This advance in sonar signal processing is typical of General Electric's many achievements in defense electronics. 227-3

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combustion (the farther apart two elements are on the scale, the greater their potential energy). Weight, which becomes a particularly important factor in the combustion products, rules out a number of otherwise promising elements.

After this initial rough screening, the thermochemists turn to references for actual bond energy figures. In those cases where bond energies are not available, the thermochemists have to establish them.

Compound Formation

From the bond energies, the physical chemist works out heat of formation of the compound. With the aid of electronic computers, he then calculates the theoretical specific impulse of the proposed new propellant. The compounds that survive these calculations are passed on to the organic and inorganic chemists, who will try to synthesize them.

Most of the synthesis work is carried out in a vacuum rack. This is a rather ingenious maze of glass tubing, flasks and three-way valves which is evacuated to a pressure of .001 mm. of mercury and sealed off from the outside air. Owing to the danger of explosion, only ½-gram quantities of material are used on the average—"just about enough to wet the tube." The maze or rack is clamped to a metal frame behind a thick plastic shield, and the chemists use arm extenders of rather original design to turn knobs, add materials, make adjustments in maze.

The system is sealed off primarily to prevent any material from being lost, particularly gaseous end products. Sealing also keeps possible toxic vapors in the system and air out. If oxygen from the air was to get into the system, it would react with some of the newly synthesized materials, thereby changing their chemical identity.

Traffic Directors

The three-way valves or stopcocks serve as traffic directors, enabling the chemists to separate the reaction products by channeling one fraction of the material into one flask, closing the flask off, redirecting part of the remaining material through another tube and into a second flask, and so on until all the end products are separated out. Often, the chemists get as many as 13 byproducts with each main product they successfully synthesize.

After they have separated the end products, the synthetic chemists try to characterize the different materials by determining their weights, vapor pressures, boiling points, etc. But even after the materials are characterized the synthetic chemist still doesn't know what he has actually made. To find out, he turns his miniaturized creation over to the analytical chemist.

It is at this stage in particular that much ingenuity is brought into play. To find out exactly what the organic and inorganic chemists have actually synthesized, the analytical chemist must run a number of tests on extremely small quantities of materials. This means that he has to devise means for testing materials without destroying or changing them.

Typical of the equipment now being used by Esso's analytical chemists is the Schlumberger analyzer which determines the hydrogen or fluorine content of a small sample in seconds by a nondestructive method known as wideline nuclear magnetic resonance. The chemist places a small vial of unknown material between the poles of an electromagnet. The sample becomes, in effect, part of a tuned circuit consisting of a magnetic field, a radio frequency transmitting coil and a radio frequency receiving coil. The analytical chemist

ARPA Solid Propellant Research Contracts

Companies and Programs		Expenditures ($000) 1959	1960 (est.)
Integrated Programs:		6,000	6,513
American Cyanamid	Esso Research and Engineering		
Dow Chemical	Minnesota Mining and Manufacturing		
Propellant Performance:		1,720	
National Bureau of Standards	Ohio State University		
University of California	Arthur D. Little		
Bureau of Mines	Allegany Ballistics Laboratory		
Aeronutronic Systems, Inc.	Rohm & Haas		
Atlantic Research Corp.	University of Chicago		
University of Wisconsin			
Specialized Synthesis:		3,840	
Magna Products	Penn State		
Duke University	New York University		
University of Florida	WADC, Materials Laboratory		
Rohm & Haas	NOTS, NOL (Corona)		
Olin-Mathieson	Allied Chemical		
Callery Chemical	Monsanto Chemical		
Pennsalt	Borden		
Peninsular Chemresearch	Ethyl Corporation		
Atlantic Research Corp.	National Research Corp.		
Propellant (Ingredients) Research:		750	
Naval Ordnance Test Station	Naval Propellant Plant		
Jet Propulsion Laboratory	Rohm & Haas		
Picatinny Arsenal			
High Temperature Research:		1,900	
Applied Physics Laboratory	Allegany Ballistics Laboratory		
Union Carbide Corporation	Cornell Aeronautical Laboratory		
Atomics International	Avco Manufacturing		
General Electric	National Bureau of Standards		
Non-Destructive Testing:			1,000
Jet Propulsion Laboratory			
Basic Research:		973	
Bureau of Mines (Pitt.)	Brooklyn Polytech		
University of California	Princeton University		
Aerojet-General Corp.	Aerochemical Research Lab.		
University of Texas	Stanford Research Institute		
Materials Research Corp.	Vanderbilt University		
Total:		15,000	18,000

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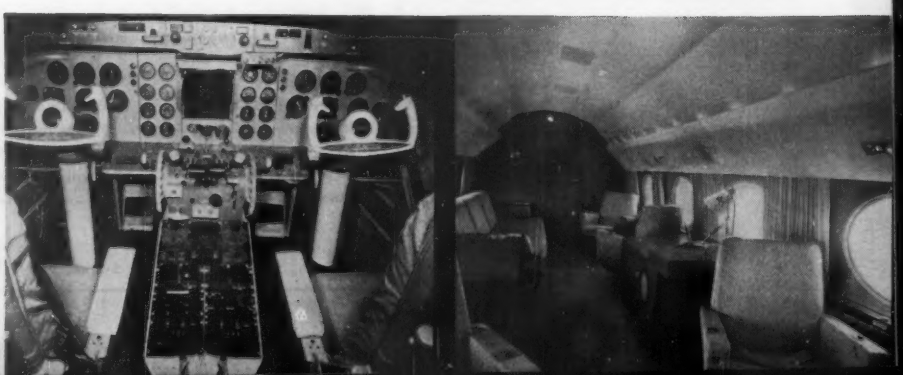
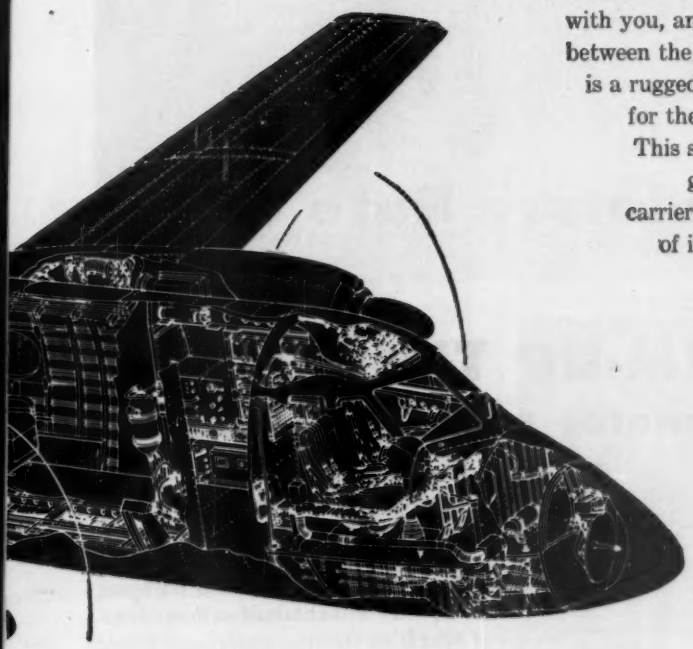


Beauty...is more than skin deep

The beauty of any business airplane must be weighed against its past. If it is a "re-do" of an older airplane, the structural stress and strain of years of operation may be invisible today, critical tomorrow. The business airplane must be qualified to meet the stringent licensing requirements demanded by today's—and tomorrow's—all-weather and high density traffic conditions.



A business airplane, like the Grumman Gulfstream, *starts new* with you, and has beauty more than skin deep. Sandwiched between the Gulfstream's clean exterior and custom interior is a rugged Grumman structure built to withstand fatigue for the equivalent of more than 50 years of operation. This structure is based on the most recent knowledge gained from designing supersonic, and especially carrier-based aircraft, required to withstand the rigors of in-fleet service. Within the Gulfstream's nacelles are two Dart turbo-prop engines, their famous Rolls-Royce reliability proven by millions of airline flight hours.

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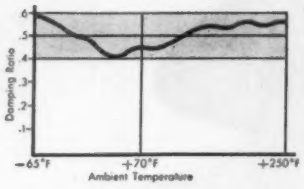

When the chips are down and immediate action is a must, the new Honeywell Miniature Rate Gyros, Type M-100, are always ready. The typical damping of 0.6 at −65°F is obtained *without benefit of heat* from the spin motor, and is held virtually constant up to a temperature of +250°F. The gyro spin motor, requiring only 15 seconds run-up time, will operate on one (split), two, or three phase power, and is isolated from ground.

Other features of the Type M-100 include: unique quadrilever spring construction to produce greater shock and vibration capabilities than a comparable torsion bar gyro; elimination of one gimbal bearing for lower threshold; maintenance of preload throughout severe environmental conditions through exclusive spin motor construction.

Type M-100 is specifically designed for autopilot damping, radar antenna stabilization, and fire control applications. Its small size, high performance, and ruggedness suit it particularly for advanced military aircraft and guided missile applications. Write for Bulletin M-100 to Minneapolis-Honeywell, Boston Division, 40 Life Street, Boston 35, Mass.

Honeywell

Military Products Group

ICBM Detection Tests

Washington—Two high-power radars will be installed on Roi Namur Island 45 mi. from Kwajalein Atoll in the Pacific by the Advanced Research Projects Agency for experimentation in the problems of detecting and identifying ballistic missile warheads from launch to re-entry.

Radar experiments will be conducted during Army evaluation of the Nike Zeus anti-ICBM missile on Kwajalein in 1962 using special unarmed intermediate range ballistic missiles with added stages to give it ICBM speeds. Vehicles will be fired from Johnston Island 1,420 mi. away.

One of the radars, produced by Radio Corp. of America, is a modified version of a tracking radar now being installed at Ballistic Missile Early Warning System (BMEWS) sites. Other radar is being produced by Raytheon. Both will be able to operate on several different frequencies to evaluate optimum frequency for detection of the warhead itself and/or its ionization sheath or trail. The program, expected to cost between $75 million and $100 million, is part of ARPA's Project Defender missile defense techniques program.

first tunes the transmitting coil to the receiving coil and then varies the magnetic field until he reaches the right ratio of radio frequency to magnetic field for resonance to occur. The particular ratio is characteristic of (and so varies according to) the element in the sample. Using nuclear magnetic resonance, chemists can also determine how fluorine and hydrogen atoms are positioned in a particular compound.

Another technique being used by the analytical chemists here is gas chromatography. Small amounts of the newly synthesized materials are placed in the gas chromatograph or vapor fractometer by means of a hypodermic needle. Inside the chromatograph is a tube filled with a selective absorbent such as a molecular sieve or silica gel.

As the unknown sample in a helium carrier, goes through the column, its various constituents pass through the packing at different rates. In effect, the absorbent column separates the different compounds in an unknown sample and permits them to come out the other end individually.

The fractometer measures and records the thermal conductivity of each constituent as it comes out. Every thermally conductive compound will produce a blip on the scaled recording strip at a time that is characteristic for that particular material. The analytical chemist then compares his recordings with those of known materials in order to identify the constitutents of the unknown

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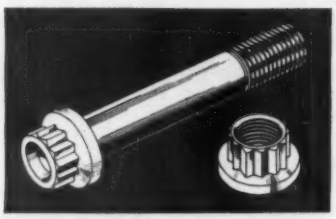
260,000 psi—with over twice the fatigue life of an MS20004

SPS laboratories for advanced fastener research are one of the few facilities in the world capable of developing and adequately testing a bolt such as the EWB 26. Each shipment of these new high performance fasteners is accompanied by laboratory certification.

Introduction of the EWB 26—a 12-point external wrenching bolt with a tensile strength range of 260,000 to 290,000 psi—marks a major breakthrough in the search for fasteners with increasingly higher strength-to-weight ratios. Pound for pound, this is the world's strongest bolt, not only in tensile values but also in shear and fatigue.

A tangible result of SPS's intensive research program, the EWB 26 offers significant advantages in airframe, missile and spacecraft applications. For example, you can use an EWB 26 in place of a conventional bolt two to three sizes as large—and proportionately heavier. Or, conversely, you can achieve desired holding power with fewer bolts, thus reducing total fastener weight. Again, in a fix, you can substitute EWB 26 bolts size for size in existing designs, with a substantial increase in strength and reliability.

The EWB 26 is one of a series of new SPS super fasteners designed to meet performance demands of our accelerated technology. And in anticipation of tomorrow's requirements, SPS laboratories are already testing even more remarkable products—fasteners of truly incredible strength.



Performance characteristics of SPS EWB 26 ultra-high-strength tension bolt at temperatures up to 550°F:

Tensile strength	260,000 psi
Shear strength	156,000 psi
Yield strength	215,000 psi
Fatigue strength	135,000 psi (at 65,000 cycles)

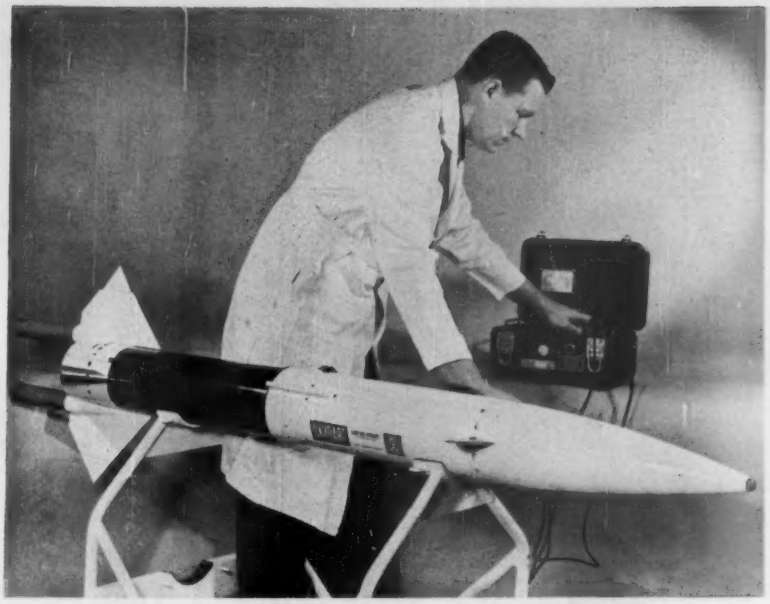
EWB 26 bolts—and companion FN 26 locknuts—are available from stock in standard sizes #10-32 through ⅜-14. Bolts are cadmium plated by vacuum deposition. For complete technical data, request new Bulletin 2527.

AIRCRAFT/MISSILE Division

JENKINTOWN 3, PENNA.

SPS WESTERN, SANTA ANA, CALIF.

SPS



First Photo of Skydart I Rocket Target

First photo of Curtiss-Wright Skydart I rocket-powered target for U. S. Air Force (AW Nov. 23, p. 23) shows unit undergoing component testing at the company's Santa Barbara, Calif, Division. Rocket motor assembly is contained in black section; autopilot, battery and gyros are in nose section. Target is designed for air-launching from a North American F-100 or a Lockheed F-104. Dual thrust rocket motor is built by Grand Central Rocket Co. and will push the target to a Mach 0.80 speed (AW July 6, p. 85).

sample. The helium carrier, which is the first material to come through the column, does not have any thermal conductivity. This non-destructive analytical technique is applicable to any material with a boiling point below 250C. (Higher boiling point compounds will not yield vapor pressures suitable for gas chromatography.)

Once the new materials are chemically identified, the next step is to experimentaly determine thermochemical properties such as heat of combustion, heat of explosion, specific heat, and so on. This is the first opportunity Esso's Special Projects Unit has to actually verify the thermochemist's original calculations that started the group on this particular synthesis. For the most part, conventional chemical equipment, such as a calorimeter, is used for these experiments. If the thermochemist's calculations check out experimentally, the new material passes on to the chemical engineer for compounding with other solid propellant ingredients. If the new material is a fuel, he calculates how much of a known oxidizer it should be mixed with. The chemical engineer is also involved in scaling up output of the new material from the original ½-gram quantities to 100-gram or possibly pound amounts in order to get the large samples required in later testing.

Mixing a new fuel with an oxidizer is potentially dangerous because there is no way of knowing how the two will react. The Esso group uses a rather unusual device called a V-mixer for this step. The mixer is made of a hollow, glass V attached horizontally inside a small glass jar. There is a small receptacle inside the top of both branches on the V-tube. Fuel is placed in one, oxidizer in the other. The jar is closed, placed on a remote-controlled roller and the two materials are mixed.

At this point in the development project, chemists are frequently faced with the problem of having to build physical properties into their new propellant system. The new synthesized fuel, for example, may actually be a liquid; then the chemists must work out a way of using it in a solid system by such means as encapsulation, gelling or the like.

The next step is to determine the burning characteristics of the integrated propellant. In one test, propellant is placed in a micro-bomb and ignited remotely. A movie camera focused through a window in the microbomb records the propellant's burning behavior. The Esso scientists also check out the propellant in a conventional strand burner. From tests such as these, they learn whether the propellant burns or explodes and what effects pressure changes have on the burning rate.

If the propellant comes through this stage satisfactorily, it is then evaluated in a miniature rocket engine. This test tells the Esso scientists whether or not

NORD CT-20

Turbo powered Radio controlled Target Drone

Zero launched from its own portable trailer, the CT-20 CAN BE EASILY TRANSPORTED AND OPERATED FROM unprepared areas. Recovery is by parachute.

Designed and built to fly like a fighter, the CT-20 offers high performance at low operating cost with a minimum of ground control and support equipment.

PERFORMANCE

Speed (32,800 FT)	560 MPH
Time to 32,000 FT	6 MIN.
Service Ceiling	40,000 FT.

Production is now underway to supply the French Army, Navy and Air Force. It has also been recommended for use by the US 7th Army in Germany.

For complete details write:

NORD AVIATION

Rue Beranger
Chatillon/Seine/Paris, France

their new compound merits further evaluation in larger motors.

Micromotors now being used by the Special Projects Unit burn approximately 15 grams of propellant and are fired in a special laboratory. The group hopes soon to have motors that will take up to a pound of propellant. The company is currently negotiating for small test stands in which the larger engines will be fired. The stands will be located on Esso's property in Linden or, possibly, they may be built and operated on some other company's property under a subcontract.

For calibration purposes, Esso will fire propellants with known properties in the larger engines along with its new solid propellant systems. The group's work will end when it proves in actual static firings that it has a new propellant which meets ARPA's goals.

Gen. Lee Stresses Anti-Satellite Defense

New York—Need for an active, long-range, anti-space-vehicle defense system, plus an anti-ICBM and anti-satellite defense, were stressed here by Lt. Gen. Robert M. Lee, vice commander, Air Defense Command, before the American Ordnance Assn.

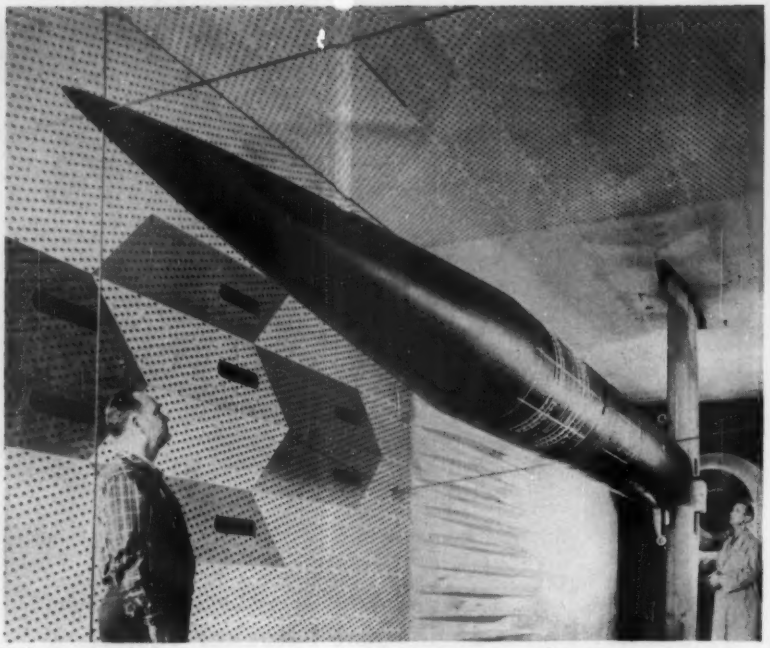
Principal reliance of the U.S. during the next two or three years, the general said, would be on precise operation of manned aircraft, with modified techniques to meet existing improvements in defenses.

Emphasizing the need for a powerful nuclear striking force, he stressed: "I foresee the threat of general nuclear war remaining" and called for "long-range aircraft with great endurance . . . a needed addition to our diversified acrospace force."

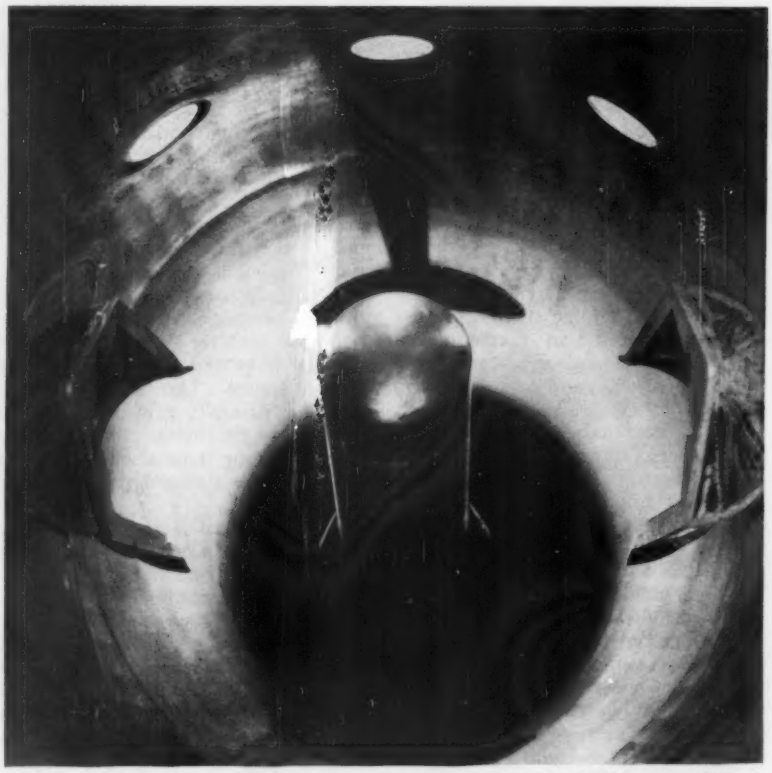
Initial capability with military satellites will be attained early next year, the group was told by Lt. Gen. Roscoe C. Wilson, USAF deputy chief of staff-development. Principal defense system in this area, now under development, is Midas (Missile Identification Detection and Alarm System) which will be integrated into SAGE and BMEWS. Satellites will provide almost instantaneous warning of the launch of enemy ballistic missiles.

Adaption for Tactical Air Command of the White Lance missile (Bullpup) developed by the Navy also was noted by Wilson, as was the programing of additional funds for an advanced fighter, beyond the Republic F-105.

Navy's need of additional surface-to-air missiles, which at present "lack sufficient range," was noted by Vice Adm. W. R. Smedberg III, commander, Second Fleet, who early next year will become deputy chief of naval operations for personnel.



Full-scale aerodynamic tests of the Army's Sergeant ground-to-ground missile have been conducted at AEDC in the 16-ft. transonic tunnel which is 40 ft. long. Rear of the missile was supported by the strut and the rocket engine was not operated. Wire bracing was required to keep the missile from oscillating unduly due to the rear-mounted test set-up. Tunnel boundary layer air is removed through holes in the wall.

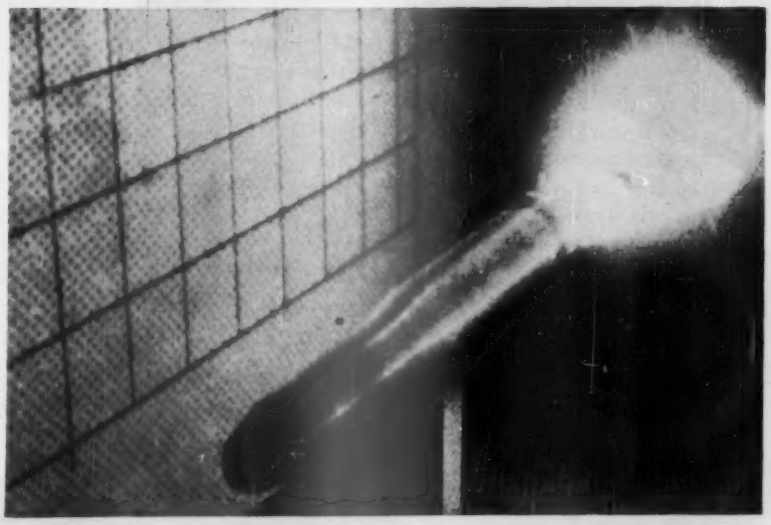


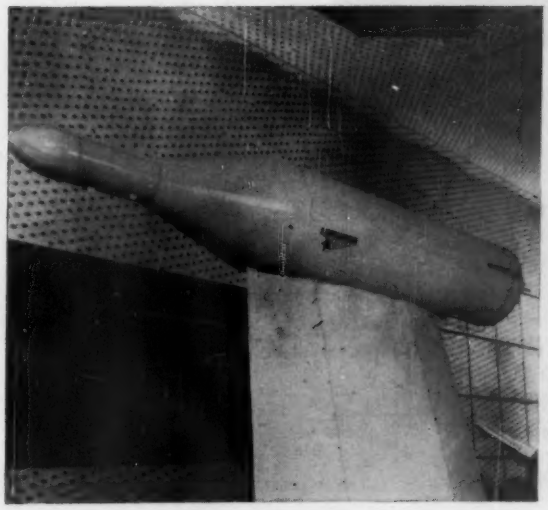
One of a series of re-entry shapes under test for the Navy-Lockheed Polaris fleet ballistic missile is shown in a Mach 8 wind tunnel at the USAF Arnold Engineering Development Center. Two halves of the cooling shoe, which is kept around the model until the tunnel test conditions are correct, are shown above retracted to the tunnel wall. Proper heat transfer measurements can be made if the model is not heated as the tunnel comes up to speed.

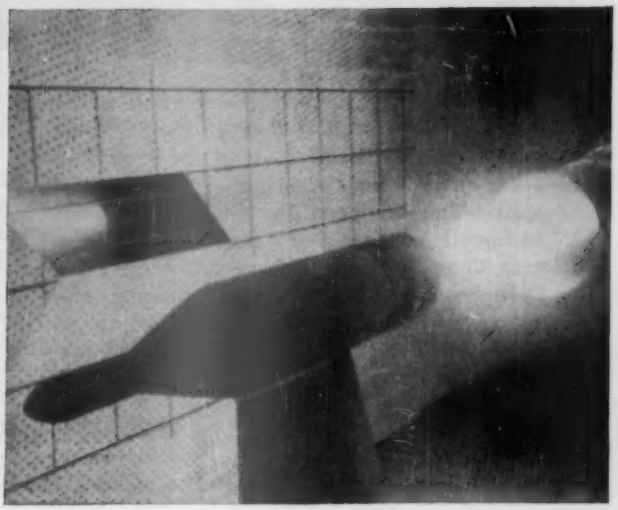
Large scale model of USAF-Martin Titan ICBM is shown as it is prepared for testing in transonic propulsion wind tunnel at AEDC.

Polaris, Titan Flow Patterns Tested at AEDC

Simultaneous testing of missile airframes and propulsion units under altitude conditions can be accomplished at the 16 ft. transonic propulsion wind tunnel at the Arnold Air Development Center, Tullahoma, Tenn., operated by ARO, Inc. Photo at lower right shows Navy-Lockheed Polaris model under test with its four rocket engines exhausting into the scavenging scoop which carries away the exhaust products to keep the tunnel air from becoming contaminated. Tunnel during this Polaris test is at near sea level pressure while for the Titan firing test at right, it is at a lower pressure, simulating a higher altitude, and the rocket exhaust has begun to balloon out filling the mouth of the scoop. Polaris model is shown at lower left. It has four liquid fuel rockets which can be used in place of a solid fuel engine for these tests.







"Hound dog," makes a B-52's shadow broader than the state of Texas

Those sharp-nosed missiles slung close to the fuselage beneath the wings of a SAC B-52 intercontinental bomber are GAM-77 HOUND DOGS with a range of several hundred miles apiece. Thus equipped, the B-52 can reach out to blast enemy resistance points over a huge area along the route to its central target.

In actual combat the inertial guidance systems in the missiles would be fed their target locations, then the missiles would be released to find their way to target at supersonic speed. Locked on target from the time of leaving the "mother ship," the missiles could be neither jammed nor decoyed.

Hound Dogs are now rolling off the production lines into flight test. Alternate missiles are being assigned to a crew, half of which consists of USAF men. This is part of the Air Force's "Blue Suit Integration Program."

The Missile Division of North American Aviation is the weapon system contractor for the GAM-77.

MISSILE DIVISION
NORTH AMERICAN AVIATION, INC.
Downey, California

AMC Contracts

Wright-Patterson AFB, Ohio—Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command:

Taylor & Gaskin, Inc., Detroit, Mich., conversion of two each, type NB-2 aircraft maintenance docks in accordance with approved design to accommodate Boeing KC-135 aircraft in lieu of KC-97 aircraft; one ea., at Turner AFB, Ga., and one ea., at Bergstrom AFB, Tex., (PR's EM-9-F-6152), $85,846.

Bill Jack Scientific Instrument Co., Salona Beach, Calf., 3,344 ea., generators, tachometer, type GEU-7/A in accordance with specification MIL-F-26611(USAF) dated Nov. 14, 1958 as modified by exhibit "A", Aerno 61-8732, Aircraft usage: F-101B, F-105D and E, F-106A and B, B-58A and B, C-130B, KC-135A, T-37A, T-39, HU-1A, G-43B and Q-2C, mobile training unit, IFB 33-600-60-20, (PR's EA-9-6620-4910; EA-9-6620-4911; ES-0-6620-6242, and amendment No. 1), $107,008.

Jack & Heintz, Inc., Cleveland, Ohio, 152 ea., generators, aircraft, 30v., d.c., 300 amp., type GEU-5/A in accordance with specification MIL-G-6162 dated June 23, 1950, and amendment number thereto dated Sept. 9, 1955, AF drawing 58C6226, Aerno 42-2031, aircraft usage: spares for HU-1A and installations for H-43B, IFB 33-600-60-60 (PR EA-0-6115-6076), $90,744.

Philharmonic Radio & Television Corp., New York, N. Y., 500 ea., receiver-transmitter RT-285A/URC-11, depot spare parts and data, and use: personal rescue equipment, (MIPR R-02-990264-SC-01-23 and amendments No. 1 and 2), $49,134.

American Machine & Foundry Co., New York, N. Y., development of semiautomatic machine for forming foil coils for transformers and reports, (PR BM-9-MMP-9145), $239,075.

Radiation, Inc., Plant No. 2, Melbourne, Fla., additional development of experimental models of radio receiver R-/UKA, end use: unknown, (PR 65215), $35,763.

Sperry Phoenix Company Division, Sperry-Rand Corp., Phoenix, Ariz., product improvement I for DR-198/AJN magnetic azimuth detector used on KC-135 aircraft, (PR EA-9-05A-4913), $69,875.

Arinc Research Corp., Washington 6, D. C., High altitude bombing component techniques and techniques for predicting reliability, (PR 85660(EADC)), $100,000.

The Magnavox Co., Fort Wayne, Ind., receiver-transmitter radio RT-463/ARC-34; control, raido set C-1057B/ARC-33; power supply PP-1990/ARC-34; spare parts, ground support equipment and data, end use: B-52G, KC-135A and F-101B aircraft, (PR's ECO-16A-6090; ES-O-16A-L302 and amendment No. 1; MIPR R59-5187-149-NOas), $1,450,105.

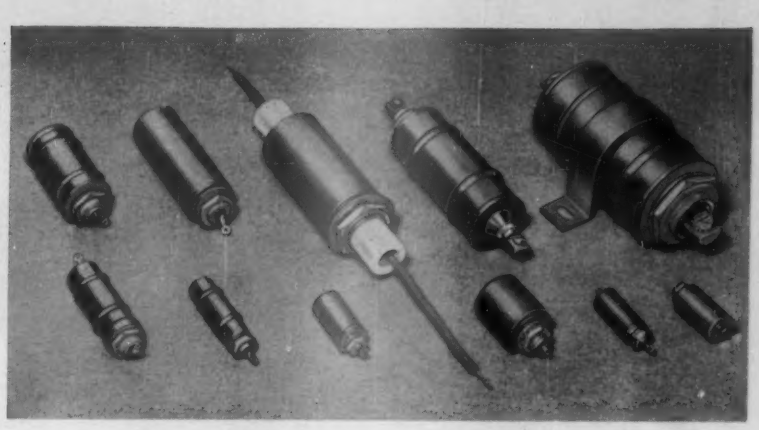
General Electric Co., Erie, Pa., 27 ea., generators, alternating current, aircraft engine-driven, 40 kva., 120/208 v, 380/420 cycle, Aerno 42-0311, contractor's P/N 2CM217A7A, for C-133B aircraft, (PR EA-9-03C-4811 and admendments No. 1 and 2), $33,102.

Bell Helicopter Corp., Fort Worth, Tex., instrumentation of HU-1A helicopter and data, for flight loads survey. (MIPR R59-902-TCSMC-A and amendment No. 8), $97,-834.

Lear, Inc., Grand Rapids, Mich., 100 ea., indicators, attitude remote, type MM-4, contractor's P/N 118769-01, Aerno 60-5940, spare parts, use: spares for F-8R and F-11F aircraft, (MIPR R59-125-NOas and amendment No. 1), $154,222.

Connecticut Telephone and Electric Co., Meriden, Conn., 3,427 ea., antenna covers, CW-141/ARN-6 in accordance with MIL-SPEC-R-25199 and amendment No. 1 dated Feb. 24, 1958, AF drawings 53F12800, 53F-12799 and 53C12782, end use: unknown, IFB 33-600-59-176, (PR MD-9-5826-37013), $41,-603.

General Electric Co., West Lynn, Mass., 120 ea., indicators, rate of flow, fuel totalizing, type MA-7, Aerno 61-2463, contractor's P/N 8DJ71GAB-1, aircraft usage: C-130B,



New Series of Sprague Cylindrical-Style Radio Interference Filters: top row, l. to r.—4JX14, 5JX94, 1JX115, 20JX15, 50JX20 bottom row—5JX27, 1JX54, 1JX113, 1JX117, 2JX49, 1JX118.

New Series of Small, Light Radio Interference Filters

The new cylindrical-style radio interference filters recently announced by Sprague Electric Company are the smallest and lightest filters of their type available for military and industrial electronic and electrical equipment. Their basic design was pioneered by Sprague in order to achieve maximum miniaturization.

This new series of standard filters, believed to be the most complete in the industry, ranges in current rating from 5 milliamperes to 50 amperes covering the majority of applications.

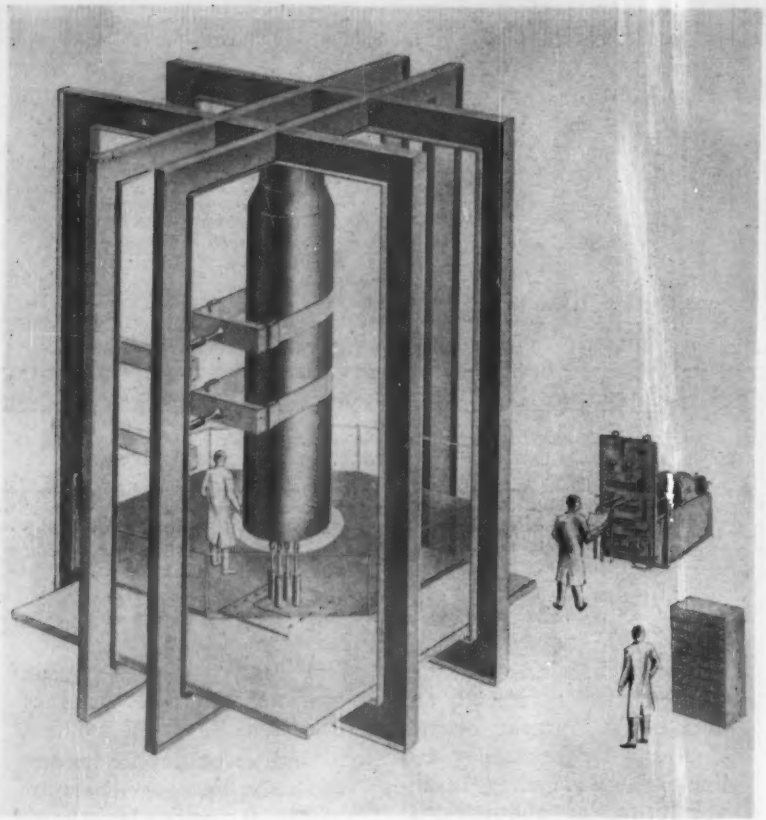
The natural shape of the rolled capacitor section and of the toroidal inductors dictates the cylindrical form. All filters have threaded-neck mountings for use on panels or bulkheads. This assures both the proper isolation between input and output terminals as well as a firm peripheral mounting with minimum impedance to ground.

Listed in Sprague Engineering Bulletin 8100 (available upon request to the Technical Literature Department) are 68 of the more popular low-pass filter designs intended for use as three-terminal networks connected in series with the circuits to be filtered. The excellent interference attenuation characteristics reflect the use of Thrupass® capacitor sections.

Since maximum effectiveness of filtering involves elimination of mutual coupling between input or noise source and output terminals, filters should be mounted where the leads being filtered pass through a shielded chassis or bulkhead. The threaded neck mounting is designed to give a firm metallic contact with the mounting surface over a closed path encircling the filtered line and to eliminate unwanted contact resistance so that the theoretical effectiveness of these units is realized in practice.

Typical insertion loss is determined by measurements made in conformance with Military Standard MIL-STD-220. Minimum curves for specific filters are available upon request.

For assistance in solving unusual interference, rating, or space problems, contact Interference Control Field Service Manager, Sprague Electric Co., at 12870 Panama Street, Los Angeles 66, California; 224 Leo Street, Dayton 4, Ohio; or 327 Marshall Street, North Adams, Massachusetts.



Polaris Test Unit Under Construction

Structural test fixture for use in the Navy Polaris missile program will look like this artist's conception when work is completed at The Rucker Co., Oakland, Calif., which will produce the units for Aerojet-General Corp. Test unit is 35 ft. high and is designed to simulate all stresses encountered during the first 1½ sec. of launch.

(PR's EA-0-6620-6029 and MA-9-05D-1235), $39,240.

Eclipse-Pioneer Division, Bendix Aviation Corp., Teterboro, N. J., three ea., development, fabrication and test of remote standby attitude indicating systems, data and reports, (PR EA-9-ST-4865), $94,828.

Lear, Inc., Grand Rapids, Mich., three ea., development, fabrication and test of remote standby attitude indicating systems, data and reports, (PR EA-9-ST-4865), $25,000.

Andrea Radio Corp., Long Island City, N. Y., 493 ea., dynamotors, DY-76A/AIC-10 in accordance with MIL-D-9227A(USAF) dated Mar. 18, 1954 and amendment No. 1 thereto, dated Mar. 20, 1956, (PR MD-9-16A-35349), $67,314.

Defense Electronics Products Divison, Radio Corporation of America, Camden, N. J., S/N 1270-096-2604 amplifier, electrical control sight, for MG-10T fire control system, (PR's WR-9-FSC-1270-923 and amendments 1, 2 and 3, and WR-9-FSC-1270-922 and amendments 1 and 2), $73,826.

Military Products Division, International Business Machines Corp., Owego, N. Y., components of AN/ASB-9A bombing navigation system, used in B-52 aircraft, (PR ES-0-11A-6380), $3,750,000.

United States Gauge Division, American Machine & Metals, Inc., Sellersville, Pa., 7,400 ea., indicators, indicated airspeed, pitot static, 40-400 kt., type MS38046W1, FSN 6003-6610-527-8450, Aerno 60-4961 (airborne aircraft accessories), IFB 33-600-60-9, (PR MA-9-6610-1111), $227,722.

Military Products Division, International Business Machines Corp., New York, additional facilities and modifications for research and development of an advanced guidance missiles program, (PR BI-9-F-9140), $500,000.

The Mitre Corp., Lexington, Mass., research and development advisory assistance for the Air Defense Systems Integration Division, (PR-88145), $3 million.

General Electric Co., West Lynn, Mass., facilities for the J-85 engine, (PR BI-F-9185), $701,350.

M. Steinthal & Co., Inc., New York, research and development of large, heavy duty parachutes, (PR 56536), $126,199.

Melpar, Inc., Falls Church, Va., development of a speech bandwidth compression system, (PR EC-9-16A-4727), $550,000.

Aero Instrument Co., Cleveland, Ohio, 2,107 ea., tube, pitot, aircraft, type AN 5812-2, Aerno 60-9630; 3,075 ea., tube, pitot, aircraft, type AN5813-1, Aerno 60-9660; 5,231 ea., tube, pitot, aircraft, type AN5816-2, Aerno 60-9200; 1,047 ea., tube, pitot, aircraft, type AN5814-2, Aerno 60-9400; 983 ea., tube, pitot, aircraft, type AN5813-2, Aerno 60-9661, (PR's-MA-9-6610-1109 (complete) and MA-9-6610-1110 (complete)), $194,233.

Ampex Corp., Redwood City, Calif., five ea., Mapex Model 807-B magnetic tape recorders; 100 ea., magnetic tape. Ampex type A-1, (PR C-003036), $54,100.

Flight Propulsion Division, General Electric Co., Cincinnati, Ohio, 28 J-79-GE-5A turbojet aircraft engines with afterburners for use with the B-58 aircraft, (PR EP-9-2840-4890), $3 million.

Westinghouse Electric Corp., Dayton, Ohio, 80 ea., generators, A.C., P/N A50J207-2, Aerno 42-0295; 100 ea., panels, control, A.C., type G-1, P/N A40A1735, Aerno 42-0731, including data for use in C-130B aircraft and SC-130 aircraft, (PR EA-O-03C-6023), $119,629; 80 ea., generators, P/N 903J822-2 Aerno 42-0330; 102 ea., panels, P/N 905D942-2, Aerno 42-0749; 263 ea., transformers, P/N A38B8971, Aerno 42-0831, for F-105D aircraft, (PR EA-O-03C-6032), $164,436.

Cincinnati Milling Machine Co., Cincinnati, Ohio, services, materials and reports necessary for the evaluation and development of high temperature machining methods for production of aircraft components from ultra-high strength materials, (PR BM-9-MMP-9148), $143,353.

Fairchild Engine Division, Fairchild Engine & Airplane Corp., Deer Park, N. Y., preparing facilities for shipment, (PR PB-9-F-9043), $25,000.

Andrea Radio Corp., Long Island City, N. Y., 700 ea., controls, C-824A; 250 ea., relay assemblies, RE-94A; 635 ea., controls, C-925A and components of AIC-10 interphone system for unknown aircraft, (PR's MD-9-16A-35320, MD-9-16A-35340 and MD-9-16A-35341), $140,000.

Hughes Aircraft Co., Culver City, Calif., engineering services and materials to provide support for F-106/MA-1 climatic hangar test, (PR EG-9-11B-4991), $60,000.

Red Bank Division, Bendix Aviation Corp., Eatontown, N. J., 800 ea., generators, P/N 30B42-1-A, for use on T-33A aircraft, (PR SA-9-03C-9303), $552,614.

Graflex, Inc., Rochester, N. Y., 345 ea., solenoids, 429 ea., adapter assemblies; 156 ea., general camera lens for replacement spare parts for KS-6, PH-47E, H and J photographic equipment, MIPR's R60-32218-SC-24, (R60-32225-SC-24 and R60-32238-SC-24), $26,320.

American Welding & Manufacturing Co., Warren, Ohio, preparing facilities for shipment, (PR PB-9-F-9043), $42,500.

The Magnavox Co., Fort Wayne, Ind., 225 ea., receiver-transmitter, radio, RT-263/ARC-34, Aerno 81-8188; 225 ea., mounting, MT-1099/U, Aerno 81-4363; 225 ea., control, radio set, C-1057B/ARC-34, Aerno 81-2333, and use: T-37A modification, (PR MD-9-16A-35332 and amendment No. 1), $790,107.

Olin Mathieson Chemical Corp., East Alton, Ill., product improvement program for type MXU-4/A cartridge, starter, aircraft engine, used on F-105 aircraft, (PR EA-9-1375-4997), $178,246.

General Electric Co., West Lynn, Mass., product improvement for type STU-7/A combustion starter, used on F-101B aircraft, (PR EA-9-03J-4938), $121,415.

Federal Systems Division, International Business Machines Corp., Owego, N. Y., components of ASB-9 bombing navigation system for B-52 aircraft, (PR's EG-9-1280-4511 and amendment No. 1; WR-9-1280-829; WR-9-1280-830; ED-9-1280-4680; WR-9-1280-4538 and amendment No. 1 and 2), $1,248,595.

Cessna Aircraft Co., Wichita, Kan., five part technical manual reproducible for L-18 liaison aircraft in accordance with Army procurement descriptions 55-1 and 55-2, (MIPR R56-605-TC and amendment No. 3 and 4), $446,358.

AiResearch Manufacturing Co. Division, The Garrett Corp., Phoenix, Ariz., 309 ea., transmitters, thrust, single synchro style, pressure ratio, type MK-2, Aerno 61-2484, spare parts, ground support equipment and data, aircraft usage: F-105D, F-105E, F-106A and F-106B, (PR PE-9-05D-4239 and amendment No. 1), $150,000.

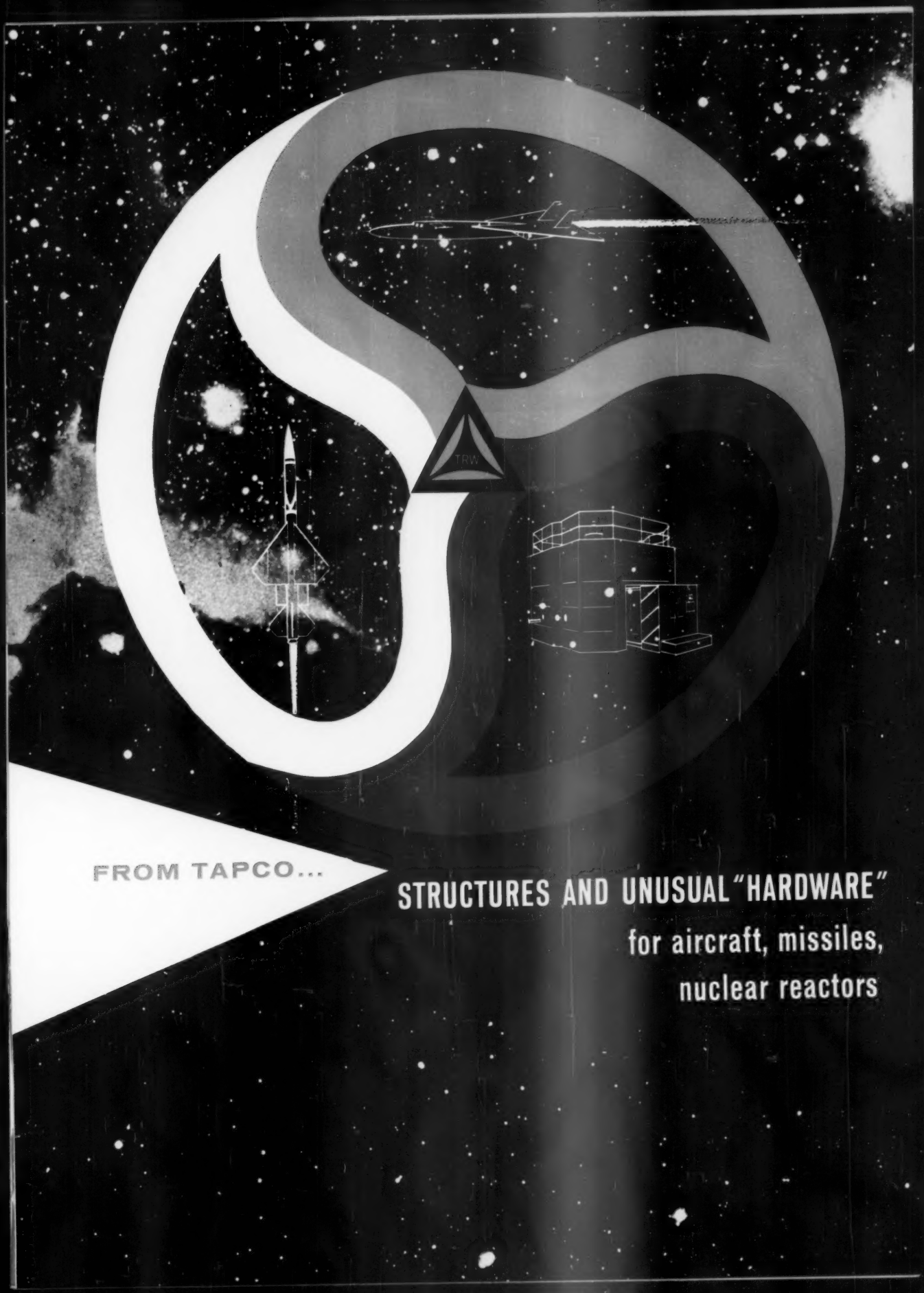
Trans World Airlines Inc., Kansas City, Mo., services consisting of receipt, inspection and storage of logistic supplies, (PR EM (O-S-6173), $28,669.

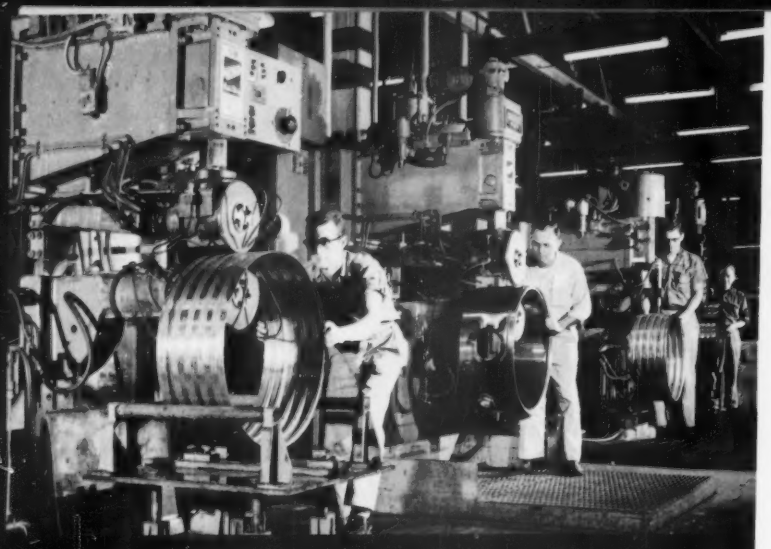
Hughes Aircraft Co., Culver City, Calif., service test of digital adapter units for AN/ARC-58 and AN/ARC-65, end use: Unknown, (PR EC-9-16A-4780), $66,904.

Rosemont Engineering Co., Minneapolis, Minn., 1,208 ea., pitot tubes, static, electrically heated, temperature controlled, 28V, type TRU-1/A, Aerno 60-9202, airborne aircraft accessories, IFB 33-600-60-6 (PR MA-9-6610-1112), $237,976.

Air Logistics Corp., Pasadena, Calif., vehicle, aircraft propelling, hydraulic, wheel, torque unit, type A/SO8A-1, spare parts and related data, (PR EM-O-2420-6100), $500,000.

Lycoming Division, Avco Manufacturing Corp., Stratford, Conn., development of the T55-L-5 engine through qualification, for: HC-1B; helicopter-Army, (PR's 57169 (MIPR R56-675-TC and amendmen No. 4), 62427 (MIPR R-59-18-TC-RE and amendment No. 3)), $1,696,800.

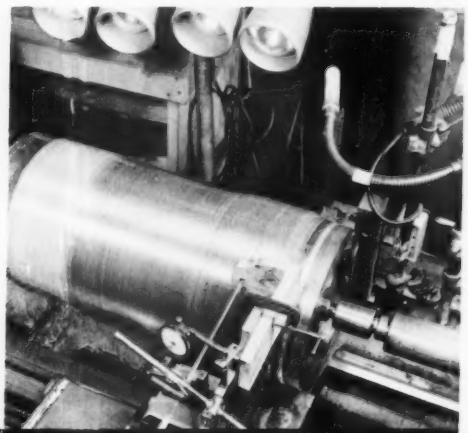

TRW
FROM TAPCO...
STRUCTURES AND UNUSUAL "HARDWARE"
for aircraft, missiles,
nuclear reactors



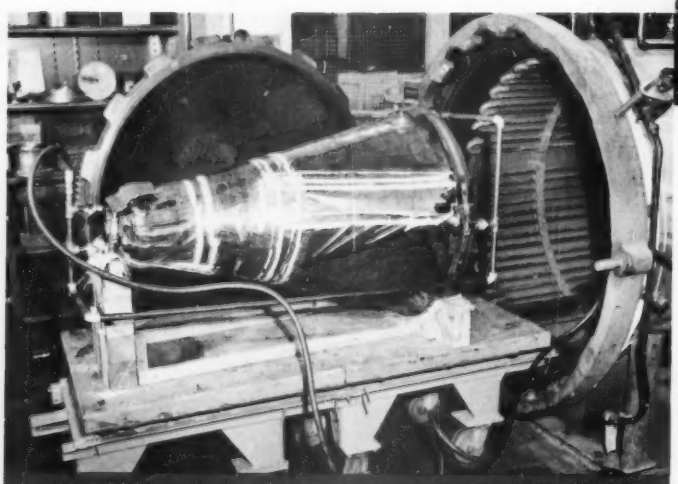
Modern seam and spot welding equipment and techniques are used at TAPCO.

TAPCO's experience in successfully working, forming and welding unusual alloys is illustrated by this high strength case made for a solid fuel rocket engine.

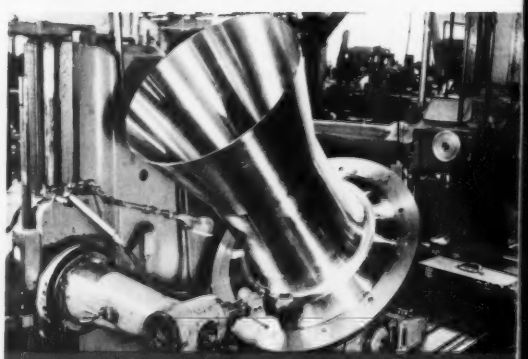
This 600-ton press at TAPCO is used to mold large exit cones for solid propellant rocket nozzles.



Winding glass fiber filaments over mandrel at TAPCO to form the shell for a reinforced plastic rocket chamber.



Special heat-resistant reinforced plastic wound altitude expansion cone being cured in autoclave. TAPCO's autoclave is 14' long — 54" in diameter.



This 30" diameter by 45" long alloy steel missile nozzle is machined to within .002 of mean contour.

Do these few examples of TAPCO facilities and products give you the impression that

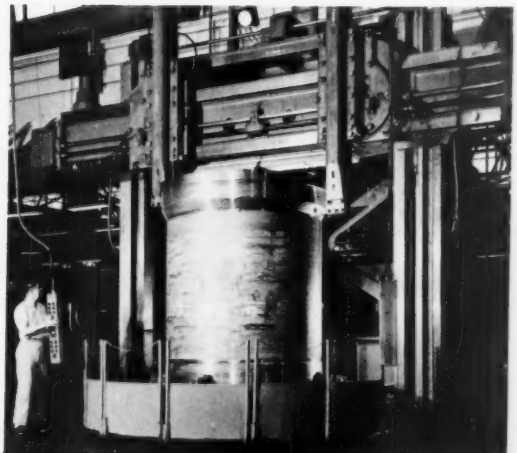
TAPCO can design...

TAPCO can build...

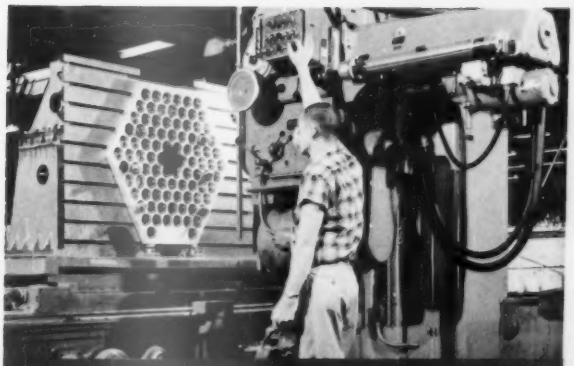
TAPCO is equipped in its 400,000-square-foot structures manufacturing area to produce, test, and deliver many different kinds of components, assemblies, sub-systems and systems?

GOOD! We'll welcome your inquiry telling us when to see you.

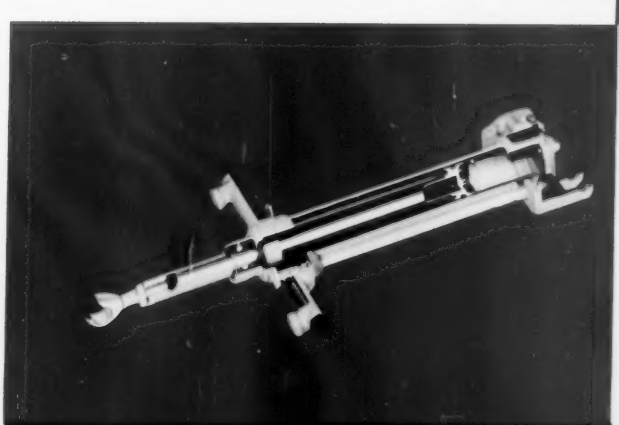
Titanium alloy rocket motor cases 20" in diameter machined from forgings, welded by shielded arc method, and heat treated by the TAPCO Group provide high strength-to-weight ratio. TAPCO has equipment to produce cases of various sizes and configurations.



This nuclear core structural component demonstrates TAPCO's capability to machine pieces up to 12' in diameter by 10' in height.



Basket segments and bottom core plates for nuclear reactors are machined and precision checked on special equipment at TAPCO.



Flotrusion and Metal Gathering processes are used at TAPCO to achieve good strength-to-weight ratios for many types of tubular members, such as the one-piece piston head and shaft in this TAPCO produced hydraulic actuator.

TRW

TAPCO GROUP

Thompson Ramo Wooldridge Inc.

CLEVELAND 17, OHIO

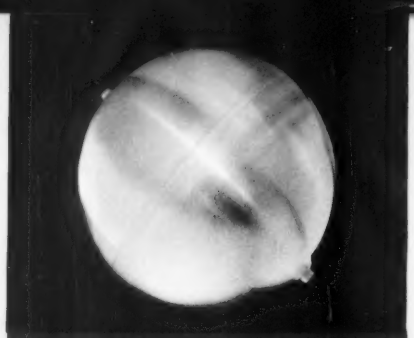
DESIGNERS AND MANUFACTURERS OF SYSTEMS, SUBSYSTEMS AND COMPONENTS FOR THE AIRCRAFT, MISSILE, ORDNANCE, ELECTRONIC, AND NUCLEAR INDUSTRIES

For some customers, TAPCO produces new structures and "hardware" from orthodox materials by new methods...

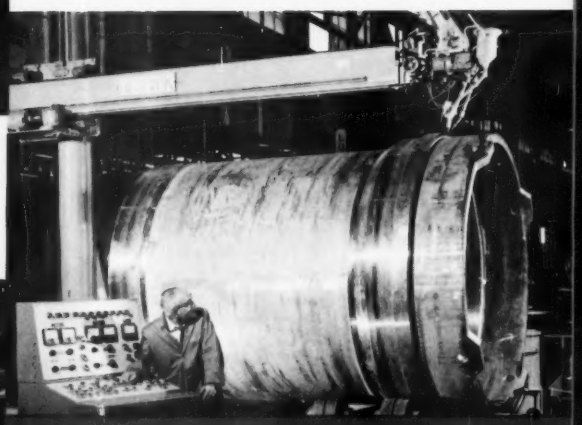
For others, TAPCO develops new materials, new techniques, new design theories...

For both groups, TAPCO functions as an integral part of the customer's organization. When would you like us to call on you?

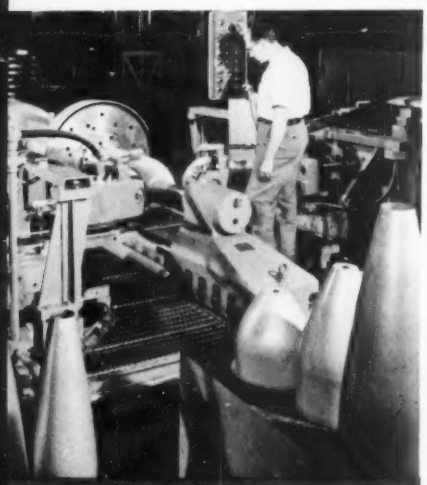
This "precision made" turbine wheel only 1½" in diameter was designed and produced from Columbium alloy by TAPCO for a miniaturized self-contained solid fueled power plant which weighs less than 4 lbs.



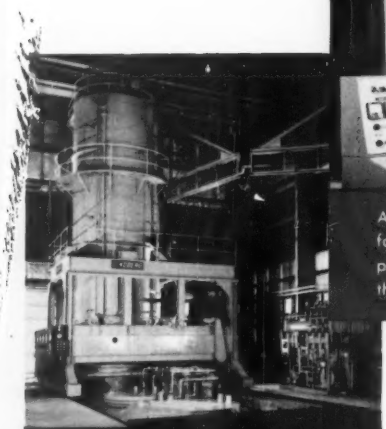
Capable of containing gases under high pressures at low temperatures, this Titanium spherical vessel was formed, welded, heat treated, and pressure tested under the direction of TAPCO development engineers.



Advanced techniques and the latest equipment for submerged and gas-shielded arc welding permit easy fabrication of components such as this 10-ton nuclear core barrel.



Ogive-shaped nose cone is an example of what can be spun on TAPCO shear spinning machines.



Pieces as large as 6' in diameter and 22' long can be heat treated by TAPCO in this new Lindberg controlled-atmosphere furnace.

There are openings at TAPCO for qualified engineering personnel. Write to Technical Placement Manager.

Quick-opening actuator-operated roof structure mechanisms for Bomarc Model II missile shelters at Eglin and Suffolk County Air Force Bases were designed and produced by the TAPCO Group.

TAPCO GROUP

Thompson Ramo Wooldridge Inc.

CLEVELAND 17, OHIO

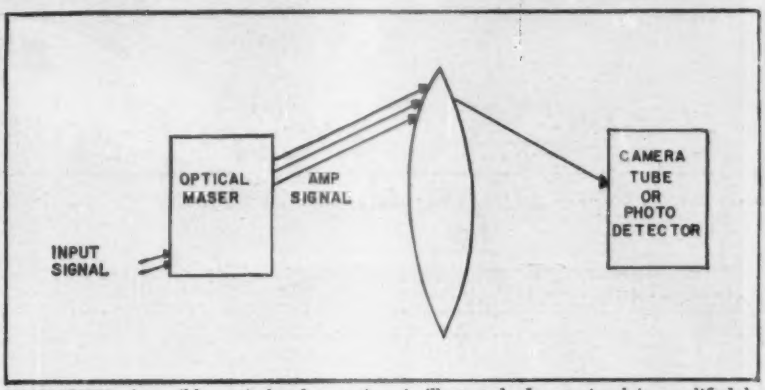
DESIGNERS AND MANUFACTURERS OF SYSTEMS, SUBSYSTEMS AND COMPONENTS FOR THE AIRCRAFT, MISSILE, ORDNANCE, ELECTRONIC, AND NUCLEAR INDUSTRIES

Optical Systems Have Space Potential

By Barry Miller

New York—Researchers are starting to take a closer look at the optical portions of the electromagnetic spectrum. Their interest is in communication and radar systems for extraterrestrial space where atmospheric absorption, scattering and background noise intensities no longer limit the use of optical waves.

Optical waves occupy that dimly defined high-frequency portion of the spectrum which ranges from somewhere in the far infrared, perhaps about 100 microns, down through the middle and near infrared, the visible and into the ultraviolet regions (2,000 to 3,000 angstroms).



SIMPLICITY of possible optical radar receiver is illustrated. Input signal is amplified by optical Maser then focused into camera tube or photo detector.

Potential Rewards

Effective active optical systems may not be easy to achieve, however. Signal sources and sufficiently sensitive detectors must be found, and ancillary acquisition techniques may be required in tracking. But potential rewards of optical systems—long range, excellent security, good accuracy, possible low costs and relative insensitivity to free electrons produced by radioactive blasts —may justify the optimism of their proponents.

Some exploratory research sponsored by the Air Force is already under way. A West Coast firm has received a Wright Air Development Center contract for examining a specific optical space communication problem.

In January, Rome Air Development Center will award a contract, valued at about $100,000, for the study of the spectral suitability of optical waves, as well as modulation and detection techniques. Farrand Optical Co., Inc., here, and Technical Research Group, Inc., in Syosset, N. Y., are among the bidders for this contract, which will be handled jointly by RADC and WADC.

For some of the proponents of active optical systems, the feasibility of these systems hinges on work now in progress on previously unavailable coherent optical oscillators and amplifiers. Bulk of this work involves government-backed development of optical Masers at Columbia University ($30,000 USAF Office of Scientific Research award for the Air Force) and Technical Research (near million dollar award from AFOSR for Advanced Research Projects Agency).

Many schemes for making an optical Maser which follows from Maser amplifier principles are under investigation. Typical of these is one in which a sensitized working medium is contained with a 10 cm. cylinder with reflecting plates at either end. An electromagnetic wave travels through the medium, perpendicular to the reflecting plates, gains energy supplied by a concentric cylindrical discharge tube, and is then emitted through a partially transparent reflecting plate. In all, Technical Research is said to be working on several different optical Maser schemes involving gaseous, liquid, and solid media, different pumping methods and waveguide and cavity configurations.

Adjustable Filters

Large power outputs are expected from some Maser systems and, it is argued, it may be easier to obtain high power at optical than at millimeter waves.

Other non-Maser types of coherent generators are in development, including a two to five micron infrared generator at the Arma Division of American Bosch Arma Corp. According to Dr. Berthold Zarwyn, head of research staff, this device will have electrically adjustable ferroelectric filters for discriminating against background noise.

Principal advantage of reducing the wavelength for line-of-sight communications below the microwave range, optical wave researchers claim, is the increase of transmitter gain for given aperture size which in turn permits a reduction in required transmitter power

Optimum Properties of Optical Receivers

Detectors	Noise Equivalent Input Power per unit Mod. Bandwidth In watt-second	Optical Bandwidth (In cps.)	Modulation Bandwidth (In cps.)
Thermal	10^{-11}	10^{15}	
Photoconductive	10^{-13}	10^{15}	
Human Eye	10^{-16}	3×10^{14}	10
Photoemissive with Maser post ampl.	10^{-17}	10^{15}	10^{9} maximum
Photomultiplier	10^{-17}	10^{15}	10^{8} maximum
with optical filter		10^{12} minimum	
with optical heterodyning		10^{5} minimum (est.)	
Optical Maser Preamplifier	10^{-18}	10^{8}	10^{8}
with heterodyning		10^{5} minimum (est.)	10^{5} minimum (est.)
Photon Counter (incoherent ampl.)	10^{-18} (est.)	10^{9} maximum (est.)	10^{7} maximum (est.)
(Microwave)	(2×10^{-22})	(10^{9})	(10^{9})

Lockheed picks J&H system for JetStar

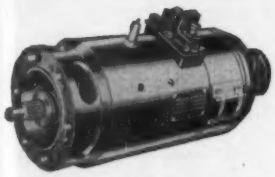
Diverse requirements of corporate and military flying in an economy-sized jet transport are brilliantly met by Lockheed's JetStar, powered by four Pratt & Whitney JT-12 engines.

For the engine-starting and electric power needs of the JetStar, Lockheed selected a starter-generator system by J&H. This system is self-contained and automatically performs all engine-starting functions except "ignition on" and "fuel on." It also provides all power-generating control and protective functions at the extreme altitude and temperature environments of the JetStar.

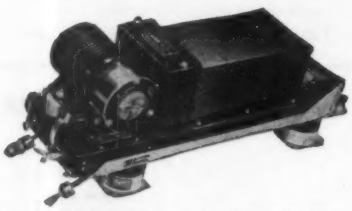
Jack & Heintz can meet your electric system needs with equal compactness, simplicity, reliability and low weight. Starter-generator systems available from J&H include manual, semiautomatic and completely automatic for the entire spectrum of turbojet, turboprop and turboshaft engines. The systems are particularly adaptable to the new, smaller jet engines rated to 4000-lb. thrust. Write to Jack & Heintz, Inc., 17635 Broadway, Cleveland 1, Ohio.

JACK & HEINTZ, Inc.

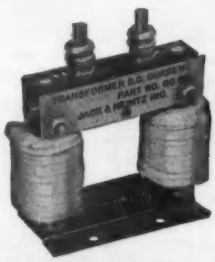
SYSTEMS FOR AIRCRAFT, MISSILES AND GROUND SUPPORT



23035 STARTER-GENERATOR: engine-driven; air-blast-cooled; for use as engine-starter and as 28-v d-c power source.



GC18 CONTROL PANEL: for use with 200-400 amp, 30-v d-c starter-generators; includes fault detection, protective and regulating components necessary on single or multi-generator systems.



GC66 CURRENT TRANSFORMERS: for generator and feeder fault detection; transformer scheme has proved superior to conventional shunt-detection method.

by the square of the wavelength. This power saving is partly offset though by an increase in the minimum detectable signal which boosts required transmitter power inversely with the wavelength. Combined, the two factors favor shorter wavelengths by the ratio of the longer to the shorter, or a factor of 10^4 or 10^5 in the optical range.

Other factors which influence optical communications include the weight and cost of reflectors, accuracy in tracking, attenuation of optical waves and relative background noise intensities.

Because the mechanical tolerances in the reflectors of an optical Maser are proportional to the wavelength, the weight and cost of reflectors of a given size rise at the smaller wavelengths.

Accurate tracking must keep the transmitter and receiver pointed at one another. Required accuracy is proportional to the ratio of wavelength to aperture diameter, and is more exacting at optical frequencies because the optical system must compensate for the poorer sensitivity of detectors by increased gain.

Optimum Properties of Optical Beam Generators

Sources	Angular Power (In watts/steradian)		Power (In watts)		Bandwidth (In cps.)		Frequency Shift (In cycles—second)	
	Peak Pulsed	CW or Average	Input	Output	Total Bandwidth	Mod. Bandwidth	Tunability	Stability
Incoherent								
Radiators								
Carbon Arc	10^7	10^7	3×10^3	1.5×10^3	10^{15}	10^8	na	na
Other Discharge	3×10^5	10^4		1	10^{15}	10^8	na	na
Reflected Sunlight	10^7	10^7		10^3	5×10^{14}	10^6	na	na
High Pressure Mercury Arc	10^9	10^7	10^3	5×10^2	10^{15}	10^8	na	na
Coherent								
Radiators								
Projected Optical Maser	(est.) 5×10^{16}	5×10^{11}	10^3	10^2	10^2	10^9 (est.)	10^{10}	10^5 (est.)
(Microwave)	(4×10^5)	(10^7)	(10^5)	(5×10^4)	(10^2)	(5×10^8)	(10^9)	(10^2)

na—not applicable

Background Noise

Atmospheric attenuation and background noise intensities traditionally have deterred extensive terrestrial use of optical communications. One argument contends, however, that an optical signal from an earth satellite relayed to an optically filtered receiver placed in a large arid desert area where cloud cover is negligible would be as unaffected as an open space.

Optical communications are advantageous in general when:

- **Aperture** of the transmitter and receiver are limited in size, as in space applications.
- **Secrecy is desired** and jamming must be prevented (then the narrow beams obtained at optical frequencies become highly desirable).
- **Freedom from interference** by free electrons such as those produced in the upper atmosphere by Project Argus type fission projects is desired.

For a system comprising a 10 cm. optical Maser transmitter, an information rate of 10^6 bits/second, and a detector with a noise equivalent input power of 10^{-17} watts/cps., and a one meter diameter receiver aperture, the average power required for Mars-to-earth transmission is 100 watts.

While some engineers may be banking on the development of coherent signal sources for optical systems, others have suggested both communication and radar systems using available incoherent sources. Farrand, which has been making what is generally regarded as short range, high precision optical radar for the past 10 years, has developed its own spark discharge sources. One millimeter diameter source provides 40 x 10^6 candles/cm.^{2}, an inherent brightness greater than that of the sun, according to Earle Brown, chief project engineer. The use of this type of source in communications would imply pulse code modulation.

Carrier Frequency

In another communication scheme proposed by Farrand, continuous white or infrared light source supplies the carrier frequency which can be varied sinusoidally in intensity at some subfrequency. This can then be modulated by conventional means.

Elcon Laboratory, Cambridge, Mass., has been studying problems involved in optical communications for the past year, according to Dr. Edwin Langberg, the firm's president. Its interest started with a proposal made elsewhere that optical waves might provide convenient communications from space vehicles re-entering the earth's atmosphere. Optical waves, it was found, are unaffected by thermally ionized gas in the shock wave surrounding a re-entering vehicle. A recently developed millimeter wave system (AW Nov. 23, p. 28) is much more advanced and appears advantageous for this specific problem, Dr. Langberg pointed out.

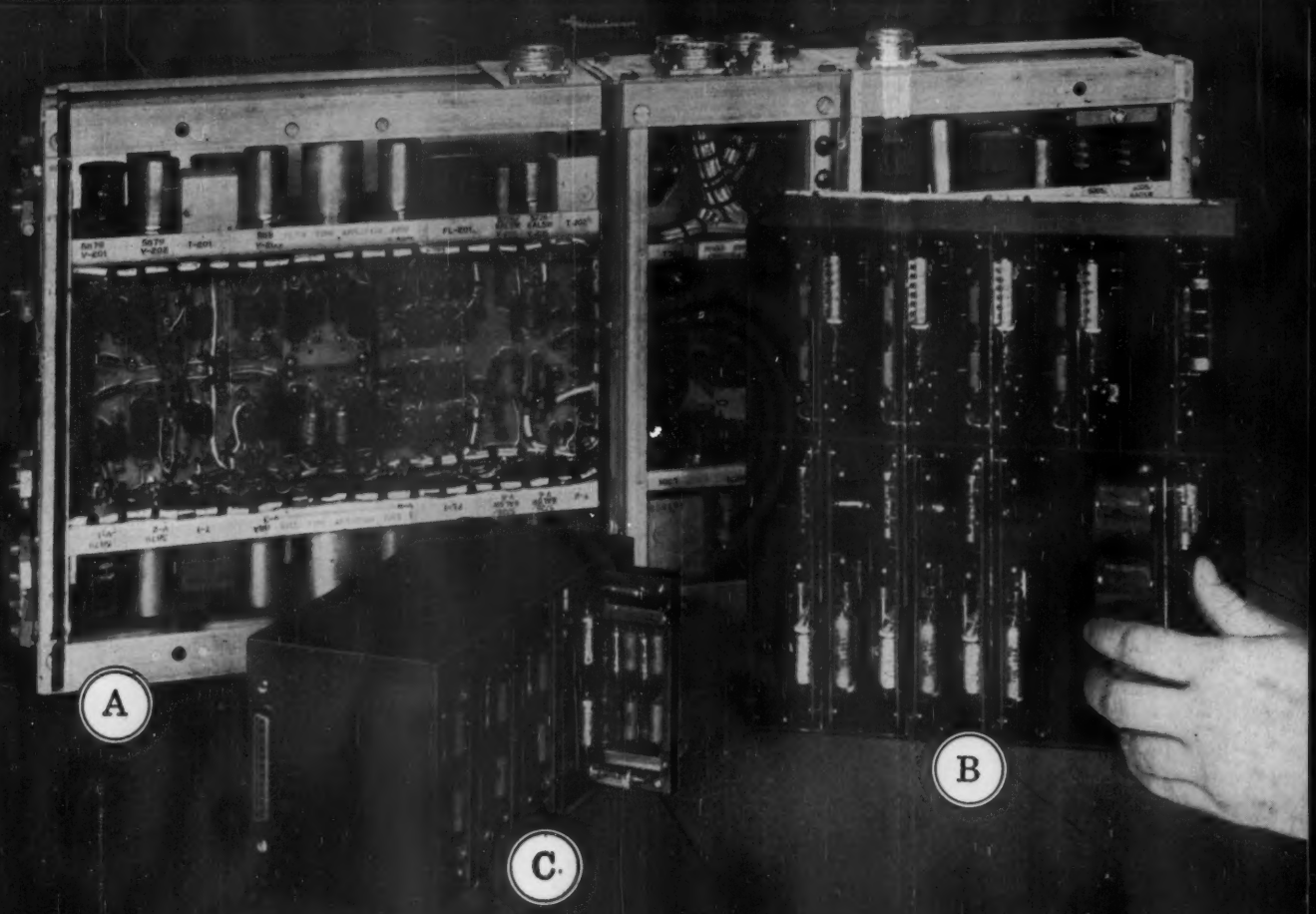
Elcon is continuing its studies of optical communication ideas and components under two subcontracts on which Dr. Langberg declined to elaborate.

At this juncture, relative costs of microwave and optical systems appear to be a moot point. One line of reasoning points out that a photomultiplier with a gain of one million would be cheaper and more compact than a microwave amplifier. On the other hand an optical transmitter with high-intensity flash source suitable for pulse modulation could effectively use only 25% of the radiated power, an efficiency lower than that of a magnetron. Yet another line of reasoning contends that the weight and complexity of a microwave system is such that for space applications an optical system is cheaper.

Reduced Wavelength

Some optical frequency proponents argue that it is useful to reduce wavelength as long as the transmitter gain increases faster than the receiver sensitivity decays. A limiting wavelength would then be approximately the shortest wavelength at which it is possible to realize a gain proportional to the area divided by the wavelength squared. Gain of incoherent sources such as arcs which is limited by the ratio of the aperture of the source diameter rather than by the ratio of aperture to wavelength is orders of magnitude less than that of potential coherent sources, this argument follows.

In Farrand's pulsar transit times of submicrosecond high intensity, light pulses are measured for detection and ranging. The returned signals are detected in a photomultiplier tube and



..... DESIGN FOR LESS C/V/W .....

Above are three stages in development, showing Stavid advances in high density packaging. Result: less cost/volume/weight.

Unit A, a portion of a guidance system developed in 1955, was redesigned by Stavid in 1958 to adapt it to mechanized assembly techniques. Although no attempt was made at miniaturization, Stavid achieved a 70% volume reduction and a 60% weight reduction—and added *a regulated power supply.* (Unit B). Unit C is the package, miniaturized through the use of solid state components.

As a result of years of experience in designing for semi-automatic and mechanized assembly, Stavid has developed an important capability . . . that of reducing volume, weight and production costs . . . and at the same time providing greater reliability, producibility and maintainability in all types of electronic equipment, including the most sophisticated systems.

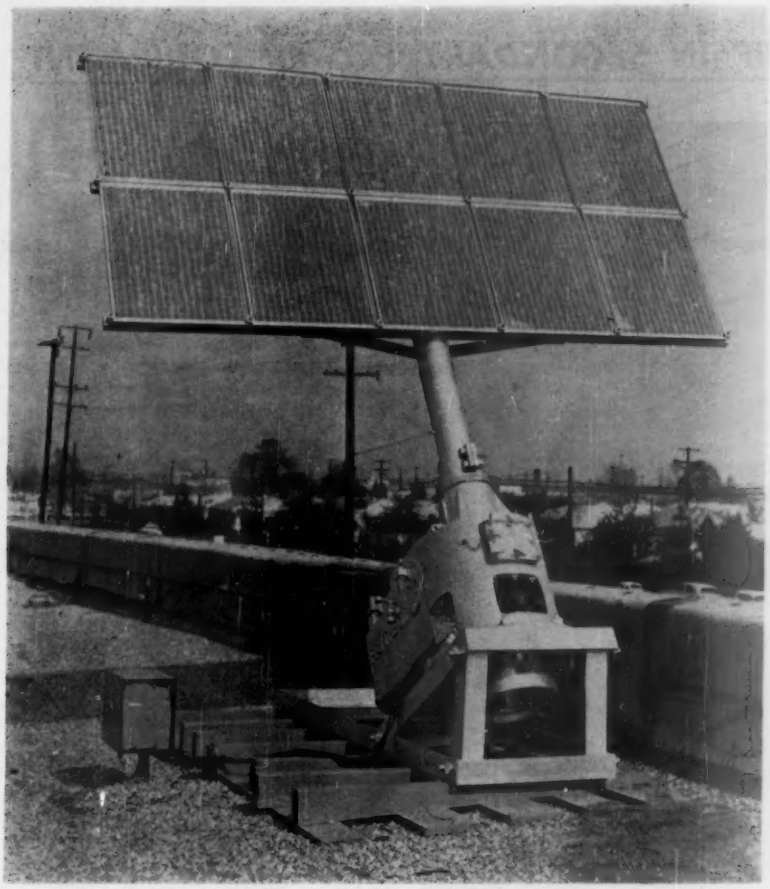
OTHER STAVID PROJECTS INCLUDE:
Video Distribution System • Precision Pulse Measuring Set • Go No-Go Test Systems

F. T. POLITICA, Special Projects Engineer, has specialized in the development and evaluation of electronic equipment, utilizing mechanized assembly techniques. He is presently engaged in a program of miniaturization involving complex missile systems.

STAVID Engineering, Inc. Plainfield, New Jersey

Imaginative Electronics . . .

Outstanding engineers and scientists are invited to inquire into opportunities on Stavid's advanced systems engineering teams.



Solar Power Converts Salt Water to Fresh

Big Bertha, largest solar power converter ever constructed, employs 7,800 silicon cells to generate power for converting salt water into fresh water at new Hoffman Semiconductor center at El Monte, Calif. Ten individual panels of cells can be connected in a variety of combinations to give an output of 0.5 to 5 amp. at 60 to 6 v. An automatic tracking device keeps the solar cells pointed toward the sun.

associated circuitry similar to that of pulse radar. Claimed accuracy is high compared with radar, equipment is lighter in weight, requires less power, and will work ground to ground where radar may be limited by back scatter. Security is its most important single asset and great improvement is expected outside the earth's atmosphere. Where corner reflectors can be used, as in friendly identification, ranges can be increased by an order of magnitude.

Extremely narrow beamwidths of proposed optical Masers, on the order of 10^{-5} radians will assure accurate tracking of targets, especially the isolation and tracking of a single target within a cluster of targets. An optical radar with the 10^{-6} radian beamwidth might resolve two targets separated by 100 ft. at a distance of 2,000 mi. System gain should be larger for a given aperture size than that of a longer wavelength system.

The optical Maser radar system, for which its proponents have coined the term LIDAR (light detection and ranging) would consist essentially of a transmitter composed of the Maser itself and some suitable modulator and a receiver with a Maser preamplifier, a lens for focusing the returned light, and a photodetector.

Primary advantage of this system, its proponents say, would be its high angular tracking accuracy although the search for targets would take a relatively long time with the small angular beamwidth. Supplementary target acquisition equipment therefore may be necessary.

Thus, in tracking an ICBM warhead and other objects from a satellite, the target could be acquired by passive infrared detection during its powered flight and subsequently tracked by LIDAR.

Possible use of the optical Maser as a radiation weapon or "death ray" has been suggested but the power densities expected from first generation devices will probably be insufficient to obtain adequate range for a weapon.

Temco to Construct Radiation Laboratory

Dallas, Tex.—New 20,000-sq.-ft. radiation systems laboratory, which will house some $750,000 worth of equipment when completed early next year, will be built by Temco Aircraft Corp. to augment present facilities now inadequate because of increasing electronics workloads.

Structure will include a 20-ft. x 20-ft. x 40-ft. anechoic chamber designed to duplicate radiation-free conditions found in the atmosphere. The laboratory will be under the direction of Dr. Chwan-Chang Lee. Electronics and missiles work currently comprises approximately one-third of Temco's $100 million orders backlog.

FILTER CENTER

Contract valued at more than $200,000 covering machining of components for a classified electronic countermeasures system has been awarded Temco Aircraft Corp. by Sperry Gyroscope Co., Great Neck, L. I., N. Y. Work comprises tool fabrication and precision machining of 10 different aluminum forgings used in the system.

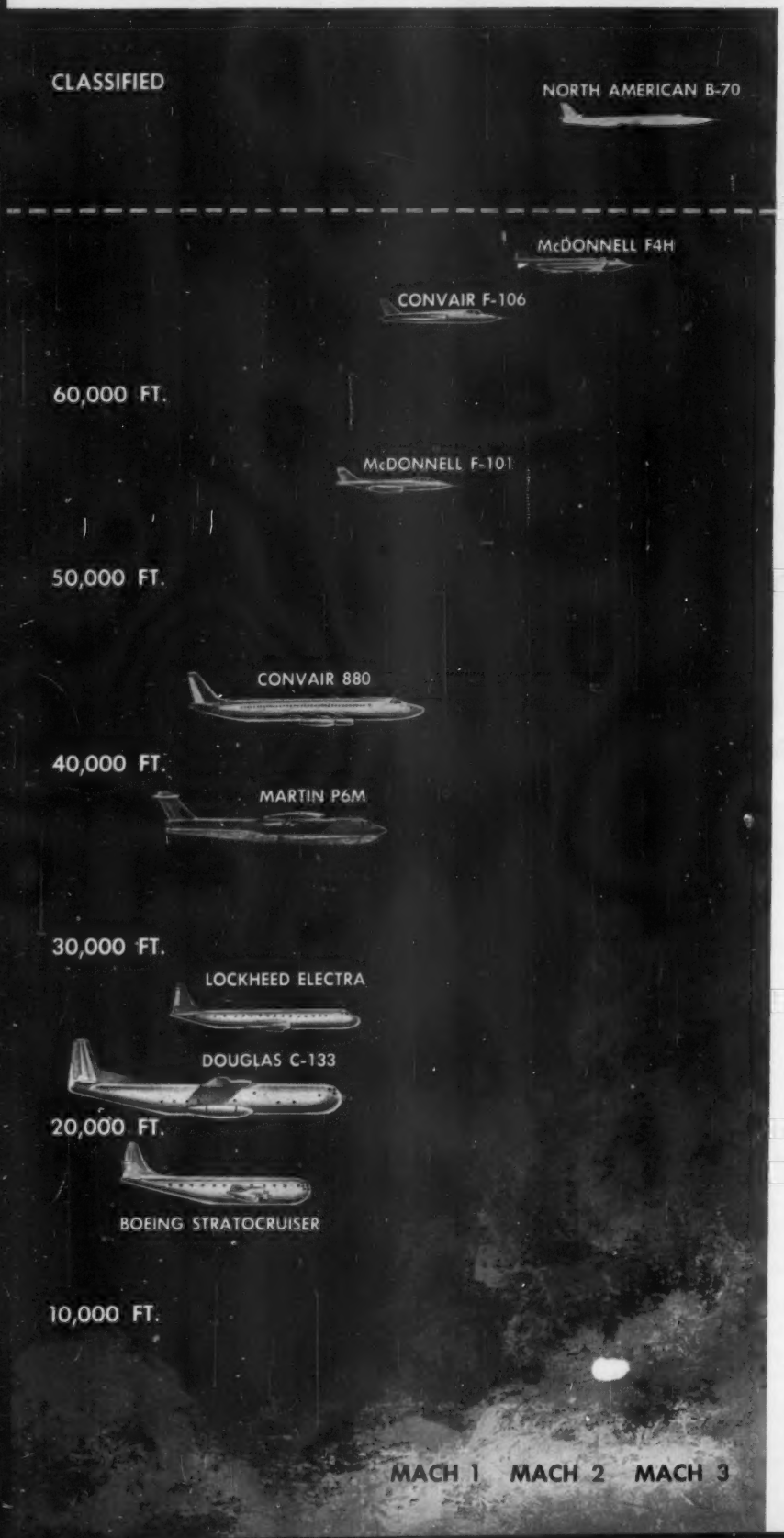
Microwave communication system production and installation contract totaling over $2 million has been awarded Collins Radio Co. by USAF. Installation, for Fairchild AFB, near Spokane, Wash., will provide communication on 7,125-8,400 mc. between ICBM control activities and launch sites.

▶ **Signed on the Dotted Line**—Major contract awards recently announced by avionics manufacturers include the following:

• **Communications Division** of Hughes Aircraft Co. has been awarded a $300,000 contract by Boeing Airplane Co. for study of launch control system communication methods for the Minuteman intercontinental ballistic missile.

• **Philco Corp.'s** Government and Industrial Division has been awarded a $6,627,092 follow-on contract for furnishing and installing equipment for the "Quick-Fix" phase of Aircom, USAF's global communications network (AW Feb. 23, p. 33).

CONTINUED LEADERSHIP IN SECONDARY POWER EQUIPMENT



General generating

General Electric has been selected to supply the advanced-design secondary electrical power generating system for the North American B-70 Valkyrie, the Air Force's new MACH 3 multipurpose bomber.* Designed for supersonic high-altitude operation with inherent long-range flight endurance and large load-carrying capability, the B-70 can be adapted to offense, defense, reconnaissance, or special airlift missions.

The new, specially designed G-E system consists of an Inductor-Lundell generator, controlled-rectifier regulator, and protective panel. The revolutionary generator, newly applied to aircraft systems, will provide extreme system reliability by eliminating normally required brushes, slip rings, commutators, rotating windings, and rotating rectifiers.

Development of this system for MACH 3 aircraft offers a challenge never before encountered in manned aircraft. New lubricating and insulating methods and new sturdy, compact construction are needed to stand flight stresses three times the speed of sound at altitudes previously unreached by operational aircraft.

Some equipment will be required to withstand temperatures of 600 F, vibration input of 15 g's (as much as 60 g's locally), and shock of 20 g's. Extreme reliability is, of course, a must.

In developing this equipment, General Electric is using experience and knowledge derived from the material and component development phase of a separate Air Force High-temperature (HOTELEC) Program under subcontract from North American Aviation. G.E.'s completely equipped research and manufacturing facilities are ideally suited to develop and produce advanced systems like HOTELEC and the B-70. And, G-E leadership in secondary power equipment extends through 40 years and more than 50 different aircraft.

*Sundstrand Aviation is manager of the B-70 secondary power system for North American Aviation, Inc.

Aircraft pictured represent only a few of those for which G.E. has developed secondary power-generating systems.

Electric's new concept in aircraft systems is awarded B-70 contract

Design Concept

Design innovations in the new G-E generating systems will provide outstanding results in these areas:

• **Reliability**—Key to the increased reliability of the G-E system, is the revolutionary Inductor-Lundell generator. Field windings and rectifiers will be located in the stator instead of the rotor as in conventional machines. Lower component temperatures result from shortening heat-transfer paths between windings and coolant.

In addition, all available control components—relays, transistors, magnetic amplifiers, controlled rectifiers, capacitors, and resistors—were fully evaluated as to performance and reliability. Then exhaustive research—speeded by computers—was conducted on individual circuits of each system to determine the combination of components which would provide maximum reliability and minimum weight for each particular application.

• **Electrical configuration**—It is planned that the B-70 system will consist of four 60-kva generators in parallel for main and emergency power. Through careful system designing, there will be a precise integration of generators with necessary control, regulating, and protective components.

Light weight—Unnecessary weight will be eliminated by (1) combining Inductor and Lundell generator principles, (2) utilizing the generator frame as flux path, (3) use of more efficient magnetic material in the frame, and (4) integrating bearing and cooling and lubricating systems with the Air Vehicle Sundstrand Drive.

Weight also will be saved in another way. In analyzing the complete B-70 system, North American electrical engineers felt that the long feeder runs from generator to load offered an excellent opportunity to evaluate a variety of generator voltages, feeder sizes, and transformer designs to determine the optimum combination. Coordination with General Electric indicated the practicability of such a design breakthrough. As a result, it was decided that power will be generated and transmitted at 240/416 volts and stepped down to 115/200 volts at the load by novel transformers designed specifically for this application. A net weight saving to the aircraft of hundreds of pounds was thus accomplished together with improvement in electrical transmission and cooling efficiencies.

Future Application

General Electric research on this system holds bright promise for future applications. Further development will make similar systems available in many future ratings and sizes for other types of aircraft. For more details, contact your General Electric Aviation and Defense Equipment Sales Office or write Section 796-1, General Electric Company, Schenectady 5, N. Y.

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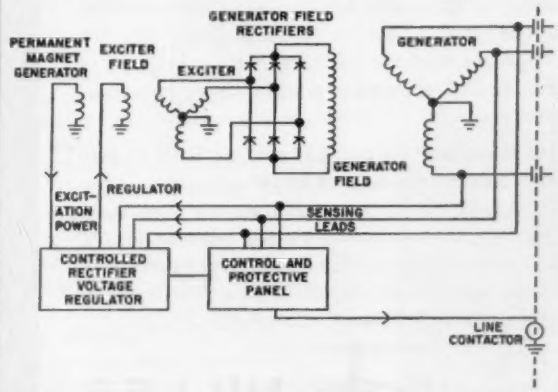
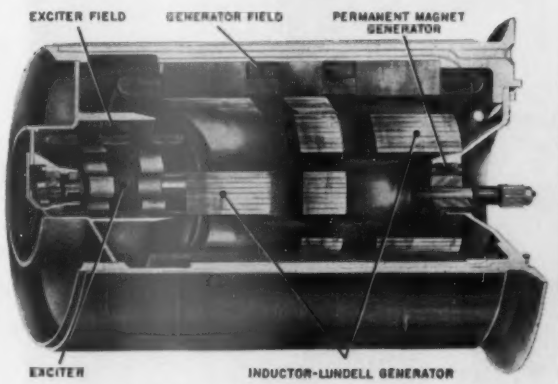
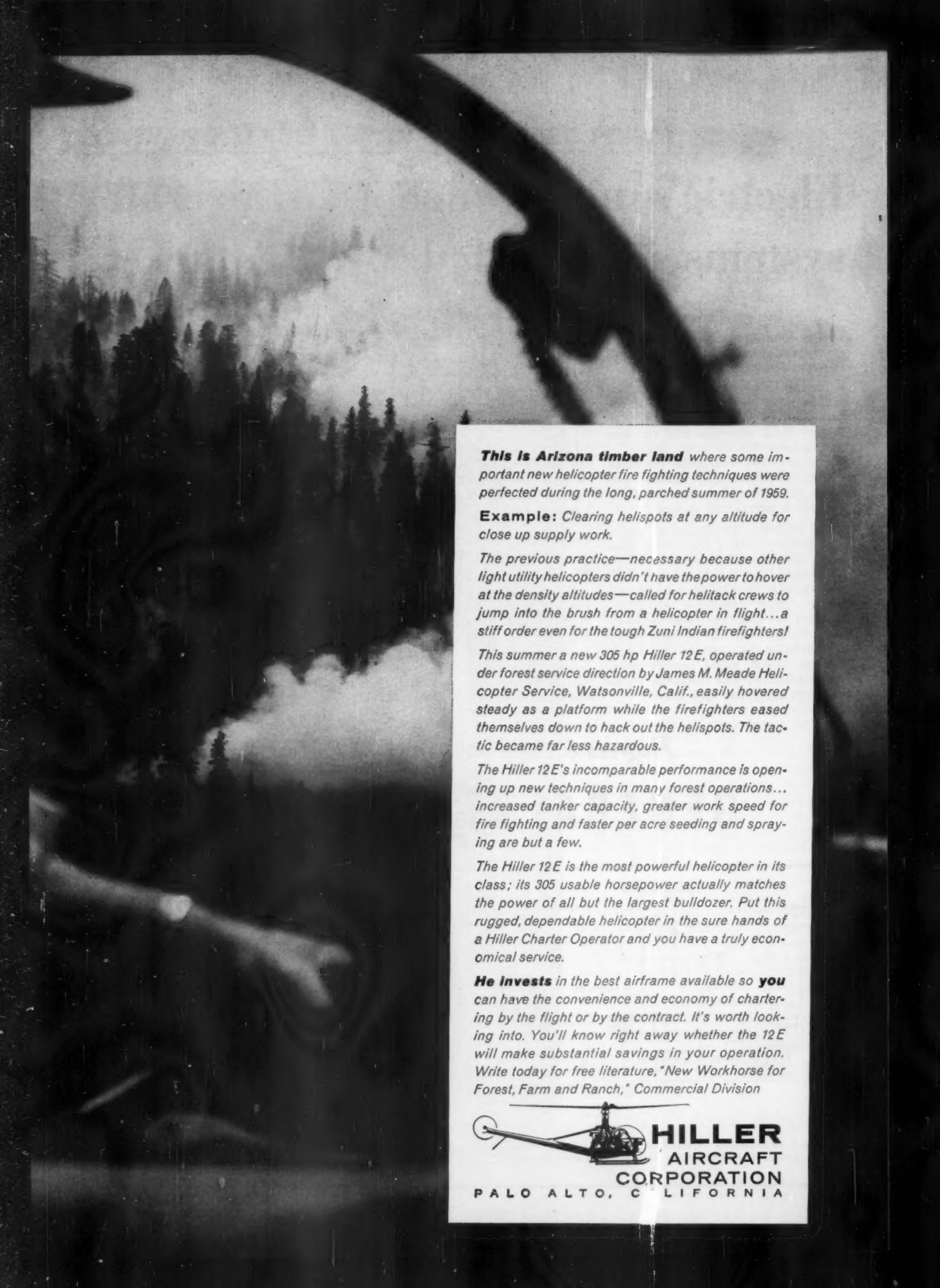


This elementary schematic diagram shows the arrangement of generator and control components.



Cross-sectional view of the Inductor-Lundell configuration of the secondary power system generator.



This is Arizona timber land *where some important new helicopter fire fighting techniques were perfected during the long, parched summer of 1959.*

Example: *Clearing helispots at any altitude for close up supply work.*

The previous practice—necessary because other light utility helicopters didn't have the power to hover at the density altitudes—called for helitack crews to jump into the brush from a helicopter in flight...a stiff order even for the tough Zuni Indian firefighters!

This summer a new 305 hp Hiller 12E, operated under forest service direction by James M. Meade Helicopter Service, Watsonville, Calif., easily hovered steady as a platform while the firefighters eased themselves down to hack out the helispots. The tactic became far less hazardous.

The Hiller 12E's incomparable performance is opening up new techniques in many forest operations... increased tanker capacity, greater work speed for fire fighting and faster per acre seeding and spraying are but a few.

The Hiller 12E is the most powerful helicopter in its class; its 305 usable horsepower actually matches the power of all but the largest bulldozer. Put this rugged, dependable helicopter in the sure hands of a Hiller Charter Operator and you have a truly economical service.

He invests *in the best airframe available so* ***you*** *can have the convenience and economy of chartering by the flight or by the contract. It's worth looking into. You'll know right away whether the 12E will make substantial savings in your operation. Write today for free literature, "New Workhorse for Forest, Farm and Ranch," Commercial Division*

HILLER
AIRCRAFT
CORPORATION
PALO ALTO, CALIFORNIA

SHERIFF'S heliport is located in 100-acre county administrative center. Communications center is located at the foot of the hill behind the hangar. County Fire Department, which uses one of the helicopters, is within five minutes of the heliport.

Sheriffs Use Bell 47s for Patrol Work

Los Angeles—Versatile utility helicopter dominates many-sided operations of Los Angeles County Sheriff's Department Aero Detail—a nine-man tactical air force for an approximately 4,530-sq. mi. area and a community of almost six million people.

Multi-skilled pilot-deputy sheriffs of Aero Detail acknowledge the special capabilities of more glamorous helicopters now on the market but would object to a one-for-one exchange of their three Bell 47G and 47G-2 utility machines. Their bias is based on operational advantages of the light helicopter, but cost alone makes such an exchange impossible, competition for tax dollars being what it is. Total capitalization of Aero Detail including three helicopters, two light fixed wing aircraft, two trucks,

DOGS used in search and rescue operations by Los Angeles County Sheriff's Department are loaded in their kennels on Aero Detail's helicopter.

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a car, trailer, machine shop and miscellaneous equipment is less than $160,000. Annual operating cost including salaries and maintenance is a little more than $75,000. The detail buys old military Bell helicopters and cannibalizes them for spare parts.

Because of the variety of missions thrust upon a law enforcement agency and rugged terrain of the county, the utility helicopter has largely displaced fixed wing aircraft. In the last half of 1958 and the first half of 1959, Aero Detail's three helicopters flew almost seven times as many hours as its two fixed wing aircraft. For most missions, a deputy sheriff must be on the scene in person, and only the helicopter makes this possible while offering quick access to undeveloped areas. The greatest usefulness of fixed wing aircraft is found in search and patrol work, but even for this mission the helicopter is now more frequently used. It lowers the danger potential of mountain searches in restricted visibility.

Types of Missions

Aero Detail missions include:

- **Enforcement** of California Aeronautics Commission Act which parallels Civil Air Regulations.
- **Forest and brush fire** suppression.
- **Re-seeding of burned-over** watershed to prevent erosion damage and silt-clogging of dams.
- **Search and rescue** of missing aircraft, boats and persons.
- **Protection of airports** and privately owned aircraft against theft and damage.
- **Patrol and atmospheric** measurement for Los Angeles Air Pollution Control District.
- **Transportation** of county technicians and officials.
- **Photographic survey.**
- **Capture of escaped** prisoners and other criminals.
- **Delivery and posting** of court orders in otherwise inaccessible areas.

Outside Cooperation

With its limited resources, the detail's job would probably be impossible without close cooperation by outside groups in private industry, other echelons of government and other county executive departments. Its central heliport is located within a 10-min. drive of the Hall of Justice in downtown Los Angeles at a 100-acre county administrative complex which includes the Fire Department, Communications Department, Sheriff's Academy, Pistol Range and Civil Defense Headquarters. One of the three helicopters is permanently assigned to the Fire Department, though manned and maintained by Aero Detail. When a fire report comes in, the pilot-deputy on duty at the heliport is alerted by telephone. A helicopter is standing on the ramp with the rotor turning and the door open within the five minutes it takes the fire chief to make preparations and drive to the heliport.

Communications Department operates several microwave relay stations to maintain contact with Fire Department and Sheriff's units throughout the county. Failure of a relay station is

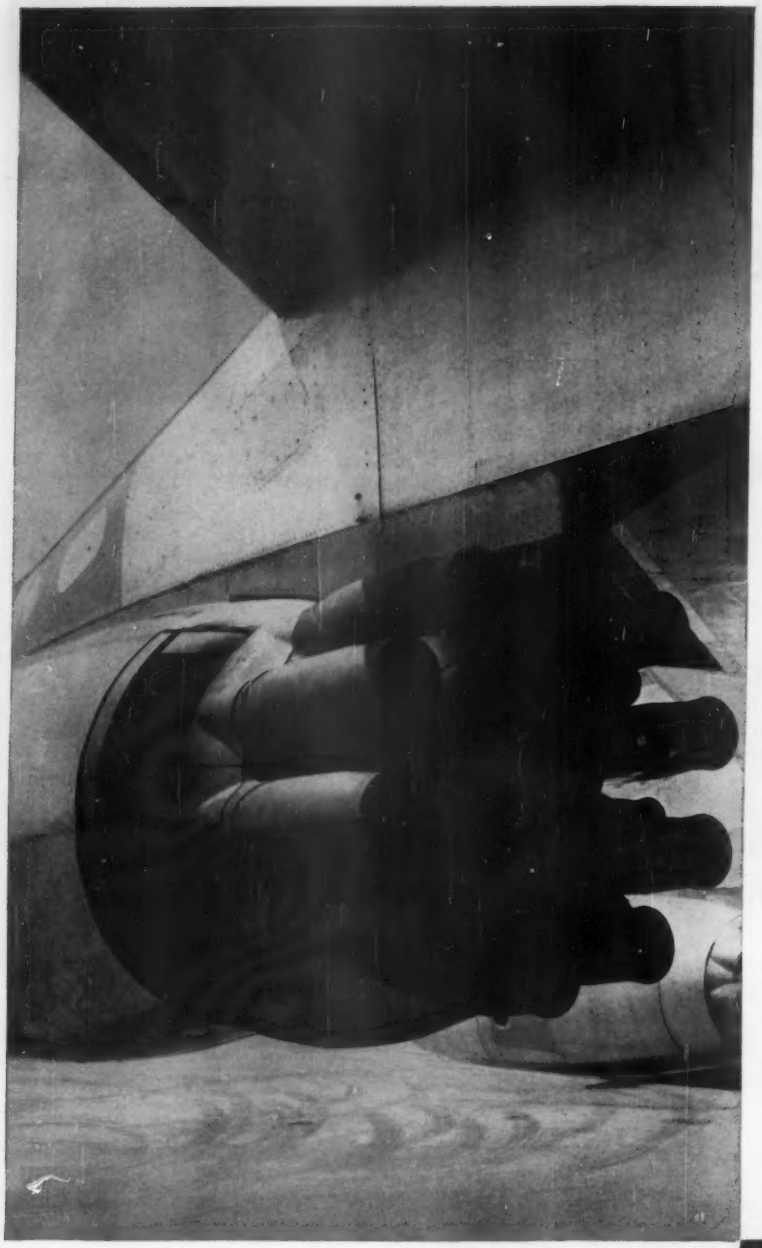
LANDING spot for Sheriff's Aero Detail Bell 47G was hacked out of brushy hillside by crewman who jumped from hovering copter and cleared the area with hand tools.

The care and feeding of a missile system

It takes more than pressing a button to send a giant rocket on its way. Actually, almost as many man-hours go into the design and construction of the support equipment as into the missile itself. A leading factor in the reliability of Douglas missile systems is the company's practice of including all the necessary ground handling units, plus detailed procedures for system utilization and crew training. This complete job allows Douglas missiles like THOR, Nike HERCULES, Nike AJAX and others to move quickly from test to operational status and perform with outstanding dependability. Douglas is seeking qualified engineers and scientists for the design of missiles, space systems and their supporting equipment. Some immediate openings are described on the facing page. Please read it carefully.

Alfred J. Carah, Chief Design Engineer, discusses the ground installation requirements for a series of THOR-boosted space probes with Donald W. Douglas, Jr., President of DOUGLAS

MISSILE AND SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ DC-8 JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND SUPPORT EQUIPMENT



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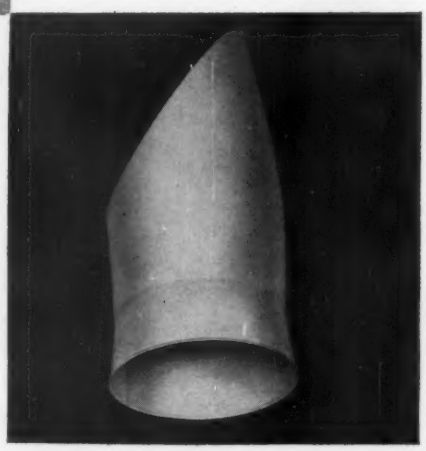
Manufacturing research is typified by explosive forming, illustrated here. Rohr began work on this technique in 1949 and more than 15,000 sound suppressor tubes have been produced using this method. Final forming of the Rohr-fabricated production units is by the Olin Mathieson Chemical Company under a sub-contract. Such research means better products at lower cost to Rohr's customers.

Rohr invites inquiries from men who can contribute to our leadership in the aerospace industry.



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CHULA VISTA AND RIVERSIDE, CALIFORNIA

likely to mean loss of radio contact with units in parts of the county blocked off by mountains. In winter, relay stations are often snowed in since most of them are located on mountain peaks. Aero Detail provides fast transportation for Communications Department technicians to get relay stations back into service quickly.

Since 1947 Aero Detail has headed a permanent Aircraft Emergency Coordinating Committee which was originally set up to cope with off-shore ditching of commercial aircraft taking off from Los Angeles International Airport. Since then, the scope of the agreement has broadened to include any emergency landing or crash. Other members are Coast Guard Rescue Coordination Center, Long Beach, Calif., Los Angeles Air Route Traffic Control Center and other FAA branches, USAF, all air carriers operating in the Los Angeles area, and all local aircraft manufacturers.

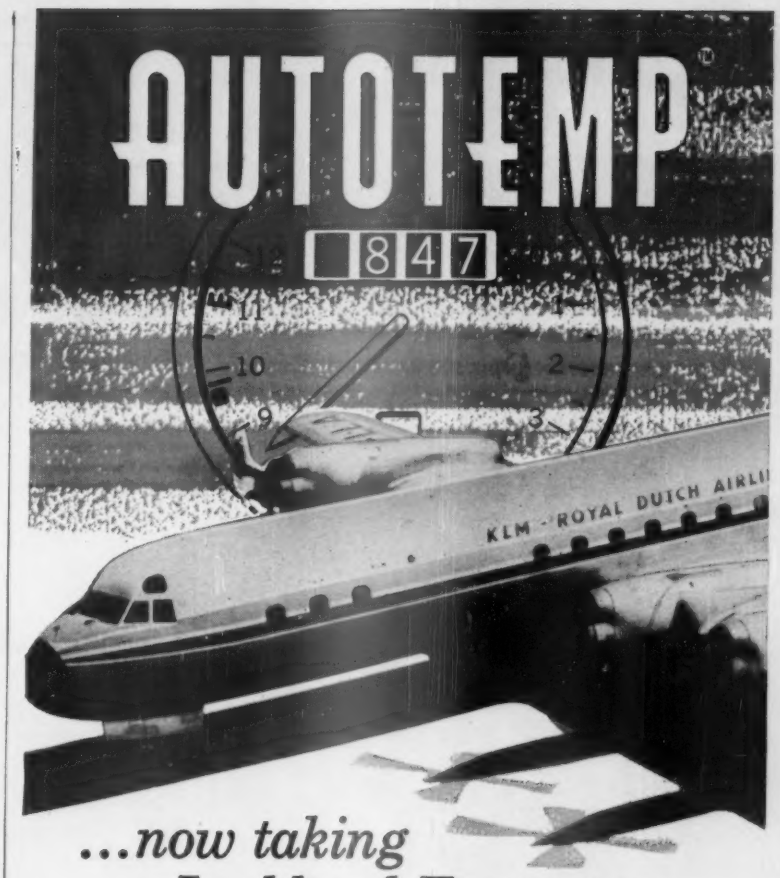
Search Teams

If an Air Route Traffic Control Center communications search fails to find an overdue aircraft at an airport or in flight, committee members are notified by telephone and Aero Detail in turn notifies California Highway Patrol, city police, county patrol cars and fire stations in the mountains. Air carriers and ARTCC alert aircraft in flight. Aircraft manufacturers maintain highly efficient search and rescue teams and a tightly knit emergency communications system in support of their flight test operations. Each of these groups has found lost aircraft or conducted successful rescues.

To fight forest fires and re-seed burned over land, state, county and U. S. forest services have mutual aid districts within which they help each other on these tasks. It is quite common to find aircraft, ground equipment, and personnel of all three working on the same fire or re-seeding job. Compliance with mutual aid agreements is generous rather than strict and no one ascertains the district boundary before starting the job.

Volunteer reserve for Aero Detail is the 100-member Sheriff's Aero Squadron whose members serve without pay and lend their aircraft on county business without any charge for fuel and oil. Fourteen helicopters and a varying number of fixed wing aircraft are available through squadron members. Several aircraft company test pilots are members of the Aero Squadron. Fast multi-engine aircraft of squadron members are sometimes used to bring back important prisoners from other states.

Perhaps the biggest part of the detail's time is spent in enforcement of the State Aeronautics Law which parallels many parts of Civil Air Regula-



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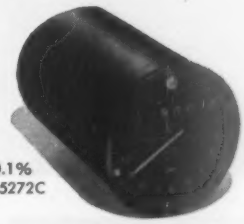

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Full information is contained in our Bulletin BH183 available for the asking!

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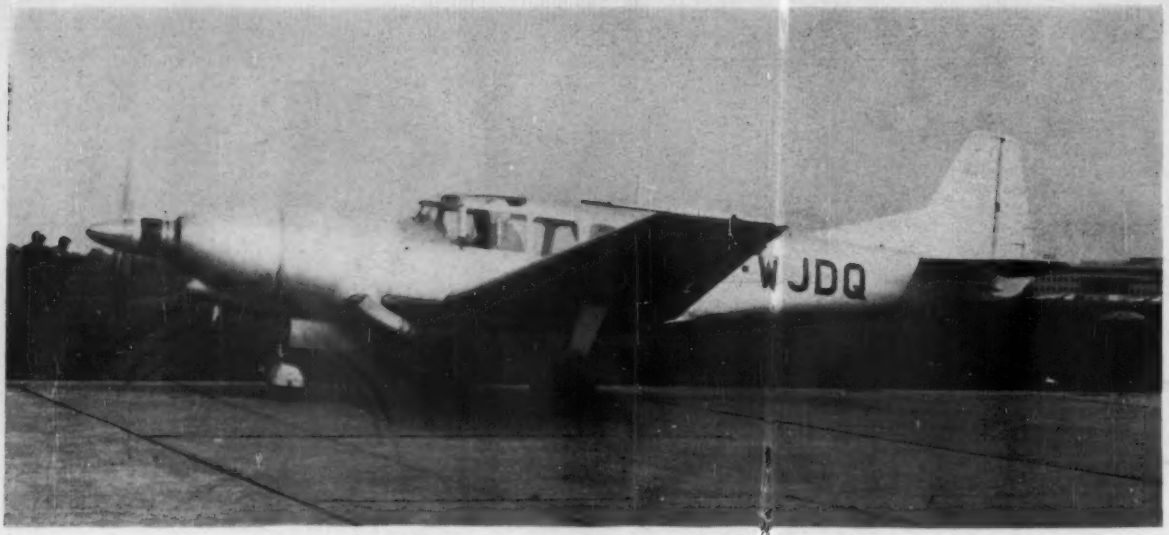

Nord 1100 Turboprop Enters Flight Tests

Flight tests of the Nord 1100 turboprop executive plane are under way following successful initial flight at Bordeaux. Plane is powered by a Turbomeca Astazou turboprop engine developing 330 eshp. Engine was adapted by Nord, Turbomeca and Ratier Figeac.

tions. Aero Detail Capt. Sewell F. Griggers says more violations of general flying rules are reported to the Sheriff's department than to any other aviation agency in Los Angeles. This is because private citizens and local officials who report the majority of such violations as low flying are more accustomed to dealing with local law enforcement agencies than with federal agencies. More often than not, investigation reveals that no violation has really been committed. Aero Detail has carried out an educational program to teach we placed observers what constitutes a vi lation. The beaches are a favorite scer of operations for low flying violato so conferences with lifeguards ha been particularly rewarding.

Conferences have also been held with airport operators to inform them of the detail's existence and set their cooperation in reporting violations committed near airports. This has been so effective that operators plagued with minor violations sometimes ask the detail to park one of its airplanes in a conspicious place on their flight lines. This has been found to induce conformity with the rules.

An annual problem for the Sheriff's Aero Detail is the New Year's Day Rose Bowl football game and parade which inevitably attracts a crowd of airborne rubberneckers. Rules published in advance require aircraft to stay above 1,600 ft. and Aero Detail aircraft try to lead them into a left-hand circle. However, there is always a percentage which goes the wrong way. A collision over the crowded stadium and streets would be a major catastrophe. The detail must cope with a strange assortment of aircraft over the game. They have had multi-engined airliners, towed gliders, light planes and towed advertising banners in the same airspace at the same time. Military jets occasionally pass through. Visibility is usually limited, for this is the smog capital of the world. Every year the detail prosecutes 15 or 20 low flyers. The mere presence of detail aircraft bearing the six-pointed gold star of the Sheriff's Department undoubtedly reduces the hazard more than the annual crop of violation reports. The value of this talisman as a stimulus of orderly behavior has been proven by patrol cars on Los Angeles freeways.

Sightseers are also a frequent problem over forest fires where they interfere with the already hazardous operation of tankers and spotter planes. As in the Rose Bowl patrol, the detail's Cessna 182 and Stinson L-5 are often used to ward off intruders. A complete file of county-based aircraft and known violators is kept in the detail's office. Low flyers are punctual in their habits and

Atlas Helicopter Accepts First Vertol 44

Atlas Helicopter Service, Inc., of Omaha, Neb., has taken delivery of its first 15-19 passenger Vertol 44 helicopter and B. T. Brown, Atlas vice president and general manager said others will be purchased as requirements indicate. Newly-formed company will use the Vertol on pipeline jobs, oil exploration, survey work and charters.

can often be caught by stationing a sheriff's airplane over the area at the same hour a week later.

Aero Detail has developed considerable skill in bush flying because of the wild and mountainous character of a large part of the county. County Fire Department has learned to provide high caliber ground support for this type of work. Sheriff's Department has trained 25 deputies from which to draw helitac crews who are the county's airborne troops. In addition to his conventional police duties, a helitac man can jump from the skid of a helicopter hovering 8 to 10 ft. above the ground and hack out a crude landing spot on a mountainside with a brush hook and a Pulaski, the ubiquitous half-mattock and half-axe developed for fire fighting. Aero Detail owns two trucks which provide ground support for the helicopters during prolonged operation from an advanced base accessible by road. Each truck carries a 135-gal. tank of helicopter fuel and a transfer pump. Aero Detail's mechanic and a supply of minor spare parts for running maintenance can also be brought to the scene in the trucks.

Attachable Equipment

They may also bring along such necessary attachable equipment as Stokes litters, powerful loudspeakers, water drop bags to extinguish spot fires, powered portable water pumps and bomb shackle-carried hose trays with which a helicopter can lay fire hose up a mountainside in a fraction of the time it could be done any other way. Telephone poles are sometimes carried into inaccessible places on the bomb shackle and dropped to linemen restringing county-owned private lines after a fire.

The same talents and techniques are as useful in search and rescue work as in fire suppression. With the helicopter it is now possible to find and investigate a mountain crash site within a few hours. Formerly, when fixed-wing search aircraft were used and rescue parties had to pack into the site, the investigation could take a week.

A typical operation occurred recently when three fishermen were lost within a few miles of residential neighborhoods in mountains so rugged that the horse of a member of the search posse slid over a cliff and was killed and a pack mule fell down a hill, smashing radio gear it was carrying. An Aero Detail helicopter finally found the lost men in the bottom of a deep narrow ravine. Gusty canyon winds prevented an immediate rescue. Food drops were made while waiting for winds to subside. A helispot was later hacked out of the brush and the rescuees were taken out from there to a road camp used as a base during the search. The posse member who lost his horse had to be rescued by helicopter, too.

Bloodhounds are often airlifted into the mountains for such searches in a pair of special carrying kennels mounted on the helicopter skids. Happily, deputies do not have to cope with airsick dogs. The bloodhounds like to fly and strain at their leashes to board the helicopter.

Forest Fires

After a forest fire Aero Detail flies flood control district experts up to the burn to estimate run-off. To prevent erosion, burned over land is re-seeded from the air with special grasses selected for the speed with which they sink a deep extensive root network. Timing of

Cessna Plant Addition Nears Completion

New addition to Cessna Aircraft Co.'s Industrial Products Division plant at Hutchinson, Kan., (foreground) is nearing completion. Experimental Laboratory, engineering building (right center) is scheduled for completion in January. Cost is about $2 million.

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- No. of Visual Output Counter Wheels: 5
- Numeral Color: White on Black
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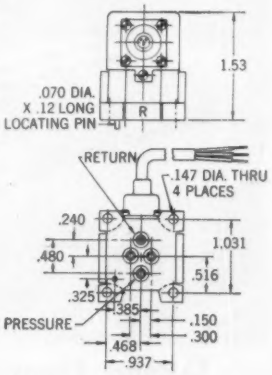

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Hiller 12E Operates in Alaskan Mountains

Operating in rugged mountain conditions, this Hiller 12E helicopter, civil version of the military H-23D Raven (AW Oct. 19, p. 98), was used by a two-man prospecting team, one of whom operates a portable drill above. The helicopter moved 34,500 lb. of equipment four miles to the location of a new exploration mine shaft in mountains of southern Alaska, delivering the cargo in a single day using 8 hr. 25 min. flying time; delivery site was 4,100 ft. high. The helicopter, powered by Lycoming VO-540-B1A engine, was operated by Livingston Air Service, Corvallis, Ore., under contract to Moneta Porcupine Mines, Ltd. During the entire contract operation, the Hiller 12E flew more than 250 hr. Company said downtime totaled three days for routine maintenance. Service ceiling, at maximum gross weight, is 14,000 ft.; cost is $59,950.

the re-seeding operation can be critical. If it is done too early in the year, the seeds will not germinate because of the long dry summers. Late in the year when rain potential is up, it is customary to re-seed immediately after the fire is out to get the root net down into the ground before erosion begins.

Arson Patrol

When an arsonist is known to be working in an area and a description of his car is available, Aero Detail will sometimes patrol the area by helicopter in the hope of catching him or at least frightening him away before any damage is done.

For emergency ambulance duty, every Aero Detail helicopter carries a kit to aid the pilot in finding one of the emergency hospitals under contract to the county. Each kit includes a map showing hospital locations. Best nearby landing area for each hospital has been preselected and a description and photograph of the site are part of the hospital selection kit. At some hospitals, Sheriff's Department radio cars must block off a section of boulevard to make a suitable landing site but new hospitals are being designed with good rooftop or lawn helispots.

Aero Detail now consists of six pilots, five of whom are deputy sheriffs; one mechanic, one ordnance officer with responsibility for all county-owned weapons who doubles as an assistant mechanic, and one secretary. The detail does all its own maintenance except engine overhauls. Two of the deputy sheriffs are rated mechanics as well as pilots.

The caliber of preventive maintenance is indicated by the fact that Aero Detail has never had to cancel a mission because of a mechanical problem.

Overhaul Cycle

Equipment is maintained according to manufacturers' handbooks. The major overhaul cycle on the Bell airframes is 1,200 hr. When 600 hr. of flying time has accumulated since major overhaul, a visual inspection is made which includes opening of the transmission and replacement of all obviously worn parts. The detail will Magnaflux all steel parts and Zyglo all alloy parts at the 1,200 hr. overhaul. Engine overhaul cycle is 750 hr. and the work is done under contract to a local shop. Spare parts inventory is kept small as the county heliport is only 30 min. from the Bell Western Division at Burbank.

BASIC BUILDING BLOCKS FROM KEARFOTT

Size 8

INTEGRATING MOTOR GENERATOR

This high performance unit is the smallest of its type available today. Accurate in the Kearfott tradition, this motor generator is thermistor compensated and characterized by an output of .5V/1000 RPM, linearity of .06% from 0-3600 RPM and output variation of temperature (—15°C to +75°C) of ±.4% from the value at 25°C.

TYPICAL CHARACTERISTICS

MOTOR SECTION	Phase 1	Phase 2
Voltage (volts)	26	40
Frequency (cps)	400	400
*Current (amp)	.119	.077
*Power Input (watts)	2.3	2.3

GENERATOR SECTION	
Excitation: 26 V., 400 cps, .067 amps., 1.4 watts.	
Volts @ 1000 RPM	.5
Phase Shift @ 3600 RPM	0°
In Phase Axis Error (mv)	1.5
Quadrature Axis Error (mv)	3
Linearity @ 3600 MPH (%)	.06

*Values measured at stall

MECHANICAL CHARACTERISTICS	
Weight (Oz.)	3.9
No Load Speed (RPM)	5500
Stall Torque (Oz.)	0.22

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COMANCHE 250 equipped with Edo 289-2700 amphibious floats. Ultimate performance could approximate that of the Comanche 180.

Comanche Tested As Seaplane, Amphibian

New York—Edo Corp., which has installed its standard Model 289-2700 amphibious floats on its own Piper Comanche 250, is optimistic over the airplane's potential as either a seaplane or an amphibian. Piper is expected to offer the airplane in one of these categories.

Comanche 250, powered by the 250-hp. Lycoming O-540 six-cylinder engine, normally cruises at 181 mph. Performance and speed with floats—which now approximates 150 mph.—is expected eventually to be on a par with that of Piper's Comanche 180 (AW Nov. 2, p. 108).

Installation of floats by Edo was made for two purposes: to permit study of the aerodynamic drag reduction of Edo float installations and to permit evaluation of the Comanche as a prospective seaplane and/or amphibian. Choice of the airplane for the former was due to its relatively high performance as a land plane suitable for float installation, AVIATION WEEK was told.

Floats currently installed were originally developed for and licensed on the Cessna 180. This model float was electrically actuated and is currently replaced by Edo's Model 489-2700 amphibious float which is hydraulically actuated. Hydraulic power stems from an engine-driven pump or a hand pump at the option of the purchaser.

Four-Month Program

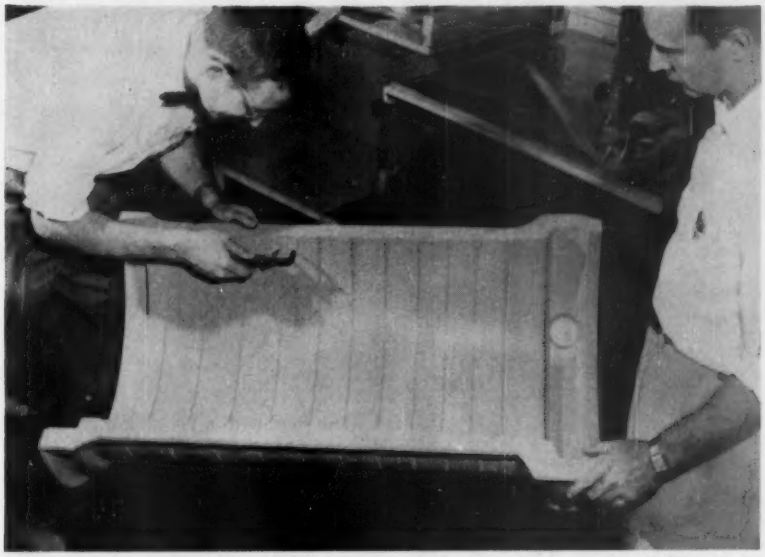
During a four-month program of drag cleanup, the cruise speed performance of the Comanche amphibian was increased approximately 20 mph. Edo believes this can be further improved and is continuing in this program. Alterations to standard float installations are being made in a manner suitable for similar application to Cessna 180 installations so that the cruise and top-speed performance of the 180 would be proportionately benefited.

Standard Comanche propeller (77-in. diameter) has been replaced by an 88-in. diameter Hartzell identical to that used in Cessna 180 seaplanes except that, in the case of the Comanche, it is full-feathering. This feature, accomplished by Hartzell, was to permit using the power-off glide technique developed by Dr. August Raspet of Mississippi State University (AW Nov. 30, p. 62) for evaluating drag reduction. The 88-in. diameter propeller has enabled the Comanche to develop similar takeoff performance to the Cessna 180 seaplane. It does not affect cruise or top speed. Cost of the Comanche 250, with floats, would be in the neighborhood of $30,000. By comparison, the standard land-plane version costs $19,800 and Piper's super custom land-plane version costs $22,800.

Edo's experimental amphibian—a smart-looking configuration that promoted considerable interest—was displayed at the recent Piper distributors' meeting at Williamsport, Pa. Display was a preliminary to the polling of the distributors about their level of optimism over the airplane's sales potential. Opinion-polling is not yet complete.

Pending decision to certify the Comanche in this configuration, it is not yet certain whether the aircraft would be simultaneously licensed as an amphibian and seaplane or just as a seaplane. Amphibious float capability means the additional increase of approximately 180 lb. of gross weight.

NEW AVIATION PRODUCTS

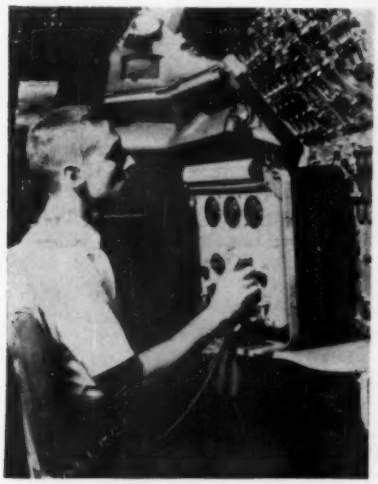


Plastic Compressor Housing Tested for Jet Engine

Pressure-molded plastic compressor housing successfully completed a 150 hr. test on a Westinghouse J34-WE-36 turbojet engine. Tests were conducted by the Gas Turbine Division of Westinghouse under Navy Bureau of Aeronautics contract. The material, a polyester resin reinforced with glass cloth, is said to be lighter, lower cost, more corrosion resistant and easier to manufacture than metal housings. The material is stronger than aluminum or magnesium at temperatures above 450F.

Flight Instrument Calibrator

Flight instrument calibration system permits flight line calibration of altimeter, Machmeter and airspeed indicator in approximately 25 min. The test equipment permits one man to make a complete check of an aircraft's



pressure instrument system and pressure sensitive emergency equipment in approximately 7 hr. A static port test adapter connects the calibrator to existing pressure system instruments.

Burton Instruments, 2520 Colorado Ave., Santa Monica, Calif.

Fire Extinguisher Valve

Fire extinguisher selector valve controls Freon fire extinguisher fluid on commercial jet aircraft.

Model MV-170A selector valve is electrically controlled from the cockpit. Weight of the zero leakage valve is less than 1 lb., port size $\frac{3}{8}$ in., normally closed, operating pressure 750 psig., operating temperature −65 to 160F.

Marotta Valve Corp., P. O. Box 330-10, Boonton, N. J.

Metallic Hydraulic Hose

Flexible, multi-ply corrugated metal hydraulic hose withstands temperatures from −450 to +1,200F and is designed to withstand cyclic hydraulic shock loadings at 4,500 psi.

The flexible hose, called RF-69, consists of an outer and inner layer of

BASIC BUILDING BLOCKS FROM KEARFOTT

PRECISE ANGLE INDICATOR

Consisting of an angle position indicator, motor and servo amplifier, this small, versatile, rack panel mounted unit provides angular position indications for laboratory, production and field use. Input signals proportional to unknown angular position of synchro device being measured are resolved as an error voltage, which is amplified and used to drive an internal servo loop to null. Counter mechanism then provides direct visual readout of angular position.

TYPICAL CHARACTERISTICS

Input Signal: S_1, S_2, and S_3 of external synchro transmitter.

Repeatability: Within 0.6 minute in either a clockwise or counterclockwise direction for any angular position.

Readability: 0.5 minute through full range from zero to 360° Rotation is continuous.

Accuracy: ± 6 minutes in the standard unit. Other accuracies available on request.

Sensitivity: 0.5 minutes maximum.

Slewing Speed: Phase sensitive, 180° in 7 seconds.

Input Voltages: 115 volts, single phase, 400 cycles, 23 VA max.

Size: Standard Rack Mounting—1¾" x 9½" x 8½"

Write for complete data.

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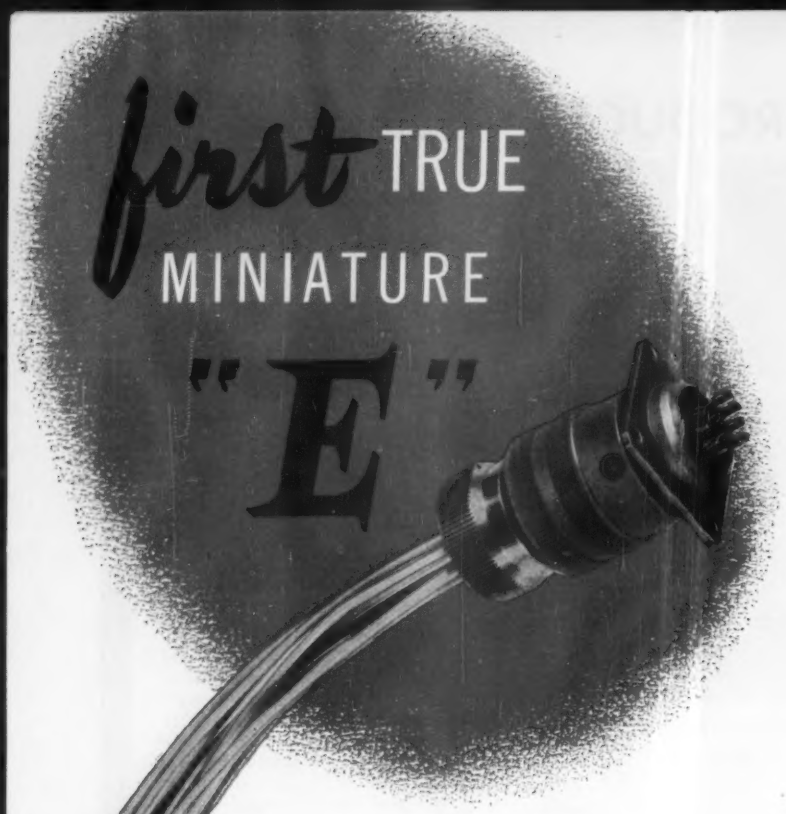
first TRUE MINIATURE "E"



altitude-moisture resistant

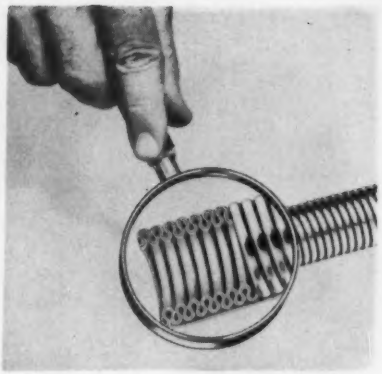
AMPHENOL *MINNIE* connectors are the first true miniature "E" types—the only miniatures able to pass the new, exacting altitude-moisture immersion test. In this test mated, wired connectors are immersed in salt water and altitude cycled to 80,000 ft. for one minute, 65,000 ft. for one-half hour and then returned to ground pressure for another half-hour. *MINNIE* insulation resistance after this test is a minimum 1000 megohms.

In aircraft, in missiles and in exacting ground and sea applications AMPHENOL *MINNIE* connectors will provide outstanding service. Any company working with environmentally-resistant connectors is invited to write for complete *MINNIE* information.

Unitized end grommet, stainless steel bayonet slots and pins, hooded socket contacts are other Minni E features.

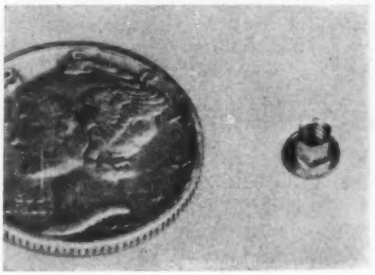
AMPHENOL CONNECTOR DIVISION

Amphenol-Borg Electronics Corporation CHICAGO 50, ILLINOIS



stainless steel with a center ply of high damping copper alloy. The hose is encased in a stainless steel braid wrap. Sizes from ¼ in. to 1¼ in. have been experimentally produced and sizes up to 2 in. diameter are planned. The hose takes standard end fittings which may be attached mechanically or by welding, brazing or soldering.

Flexonics Corp., Maywood, Ill.

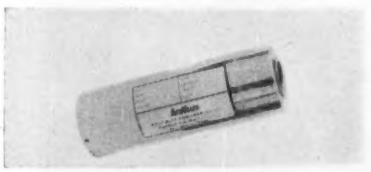


Miniature Nut

Miniature all-metal, self-locking nut is designed for fastener applications in electronic systems of missiles and aircraft.

Dimensions of the Kaylock H14-02 nut are: height: .095 in.; base diameter: .172 in.; wrench hex size: 3/32 in.; weight: .02 pounds per hundred.

Kaynar Mfg. Co., Box 2001, Terminal Annex, Los Angeles 54, Calif.



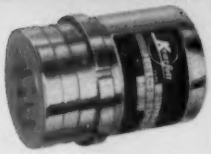
Liquid Hydrogen Valve

Stainless steel in-line safety relief valve, designed for cryogenic fluids, now is in operation at liquid hydrogen production facilities.

The valve operates in pressure ranges from 10 to 10,000 psi. It is described as "bubble tight" prior to opening and upon reseat, and successfully opens and closes without freezing.

Specialty Engineering Co., 264 W. Fairview, San Gabriel, Calif.

BASIC BUILDING BLOCKS FROM KEARFOTT



FLOATED RATE INTEGRATING GYROS

Specifically designed for missile applications, these Kearfott miniature gyros operate efficiently at unlimited altitudes. Their outstanding accuracy and performance make them superior to any comparably-sized units on the market. Hermetically sealed within a thermal jacket, these gyros are ruggedly designed and completely adaptable to production methods. Performance characteristics that are even more precise can be provided within the same dimensions.

TYPICAL CHARACTERISTICS

Mass Unbalance:
Along Input Axis: 1.0°/ hr maximum untrimmed
Standard Deviation (short term):
Azimuth Position: 0.05°/hr
Vertical Position: 0.03°/hr
Drift Rate Due to Anisoelasticity
Steady Acceleration: .015°/hr./g^2 maximum
Vibratory Acceleration: .008°/hr./g^2 maximum
Damping:
Ratio of input angle to output angle is 0.2
Characteristic Time: .0035 seconds or less
Weight: 0.7 lbs.
Warm-Up Time: 10 minutes from −60°F
Life: 1000 hours minimum

Write for complete data.

BASIC BUILDING BLOCKS FROM KEARFOTT

20 SECOND SYNCHRO

This synchro, just one of a broad line offered by Kearfott, provides the extreme accuracy required in today's data transmission systems. Kearfott synchro resolvers enable system designers to achieve unusual accuracy without the need for 2-speed servos and elaborate electronics. By proper impedance, matches up to 64 resolver control transformers can also operate from one resolver transmitter.

TYPICAL CHARACTERISTICS	SIZE 25	
Type Resolver	Transmitter	Control Transformer
Part Number	Z5161-001	Z5151-003
Excit. Volts (Max.)	115	90
Frequency (cps)	400	400
Primary Imped.	400/80°	8500/80°
Secondary Imped.	260/80°	14000/80°
Transform. Ratio	.7826	1.278
Max. Error fr. E.Z.	20 seconds	20 seconds
Primary	Rotor	Stator

Write for complete data.

BASIC BUILDING BLOCKS FROM KEARFOTT

MINIATURE VERTICAL GYRO

Provides accurate vertical reference in the form of two 400 cps synchro signals proportional to sine of gimbals' displacement about pitch and roll axes. Gravity-sensitive vertical reference device provides electrical signals directly to torque motors which maintain gyro spin axis perpendicular to earth's surface. Hermetically sealed and impervious to sand, dust, sun, rain, salt, spray, humidity or fungus as specified in MIL-E-5272A.

TYPICAL CHARACTERISTICS

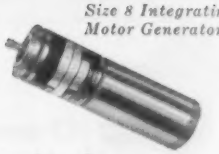
Free Drift Rate:
Within 0.5° in one minute time.
Shock:
The gyro operates satisfactorily without damage after 60g shock of .015 seconds duration.
Hermetically Sealed:
These instruments are hermetically sealed and are not affected by sand, dust, sunshine, rain, humidity or fungus conditions.
Operating Temperature Range:
Gyros operate in ambient temperatures below −20°C to +100°C. A maximum of 3 minutes of operation at 400°F will not damage these gyros nor impair their accuracy.
Weight:
5.5 lbs. approximately.

Write for complete data.

Time Index Digitalizer

Precise Angle Indicator

Size 8 Integrating Motor Generator



Engineers: Kearfott offers challenging opportunities in advanced component and system development.

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SILICONE NEWS from Dow Corning

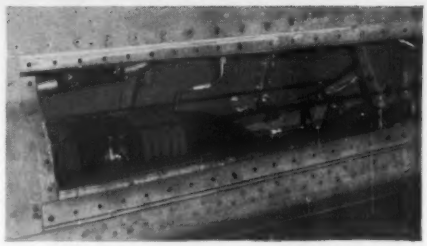
Many Parameters, One Elastomer

SILASTIC meets varied specs in Convair F-106

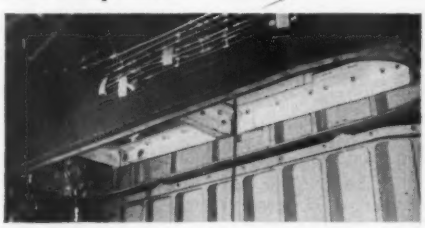
When you're calling out materials on a plane or missile, isn't it a help to have one material that can meet a variety of rubber needs? A material that's been proven in all flight regimes? Engineers at Convair San Diego, Div. of General Dynamics Corporation found it so. The material is Silastic, the Dow Corning silicone rubber, and they specify it for many applications aboard the Mach 2-plus F-106 all-weather interceptor.

A few of the uses are illustrated here. At left you see molded parts . . . plug connectors used for checking out instrumentation. Located in the aft missile bay, they are subject to high flash temperatures during rocket firings. The reliability of Silastic in this part is reported excellent, with no failure even in the presence of chemicals or exhaust gases. (Wire bundle clamps are also of Silastic.)

A completely different application of Silastic is shown at right top: one of many connectors in the air bleed system. All connectors are covered with a flexible bellows of glass-reinforced Silastic. The duct beneath carries air at 800 F, and though there is insulation between steel duct and cover, the Silastic must still tolerate high temperatures while retaining its rubberiness and sealing ability.



Among other seals of Silastic aboard the F-106 are these hollow extrusions on the air-conditioning compartment door. They withstand severe temperatures, maintain a firm air-seal after extended lengths of time under compression.



Silastic stays rubbery from —130 to over 500 F; resists aging, weathering, oxidation. Your rubber parts supplier will engineer a part made of Silastic to add reliability to your design. For name of nearest fabricator or more data, write Dept. 0924.

If you consider *all* the properties of a silicone rubber, you'll *specify Silastic.*

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

Airlines Refine Jet Transport Operations

By Russell Hawkes

San Francisco—Air carriers must resist the temptation to raise the gross load of transport aircraft when turbofan engines become available and use greater thrust for quieter takeoffs, James T. Pyle, deputy administrator of Federal Aviation Agency, told airline operators at the National Turbine-Powered Air Transportation Meeting of the Institute of the Aeronautical Sciences.

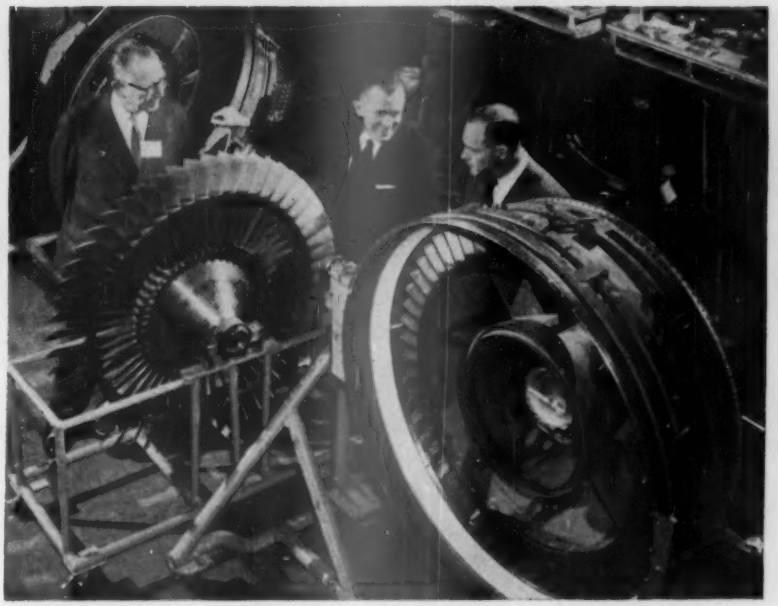
Pyle said noise suppressor research has not been as productive as originally hoped for. Research must continue and be broadened and means must be sought to quiet compressor whine as well as exhaust noises.

Pyle said increase in maximum length of federally-sponsored runways from 8,400 ft. to 10,500 ft. made in preparation for the current generation of jet transports was the final extension. He said no federal aid will ever be given to communities for construction of runways longer than this. Pyle called the final limitation a necessity because of the rapid increase in airport real estate and runway construction costs which must eventually be passed on to the passenger. This extra burden is contrary to the best interests of the industry and the nation, he said.

Cargo Aircraft Loans

Pyle said FAA is preparing to recommend legislation under which the government would guarantee loans for the purchase of "efficient cargo aircraft." FAA is also trying to divert increasing quantities of military traffic to certificated air carriers which are aggressively modernizing their cargo fleets. "We believe these incentives will stimulate industry to greatly expand its cargo capability," he said.

Pyle noted the competitive threat of the Soviet Union's Aeroflot, largest air carrier in the world. While Aeroflot's present fleet contains about 90% piston aircraft and about 10% jet aircraft, its goal is to achieve a 95% turbine-powered operation within five years. The technical effort will be linked to a powerful sales drive for more domestic service and international service. Pyle said, "Necessity for a sound return will not hamper the Communist drive. The Soviet civil air campaign will be one of prestige, propaganda and never-mind-the-cost. The order of the day will be undersell." To compete, American industry must not only improve the product, but must find a better sales approach, better financing arrangements and better customer service, he said.



MAJOR COMPONENTS of General Electric CJ-805-23 aft-fan turbojet engine are shown by Neil Burgess (center), manager of General Electric's Commercial Engine Operation, to Walter Berchtold (right), Swissair president, Ernst Schmidheiny (left), Swissair chairman.

Describing the vital importance of ground support to jet airline operations, W. C. Mentzer, United Air Lines vice president-engineering, said United has invested $6 million in ground equipment for its fleet of 40 Douglas DC-8s. This amounts to $150,000 per airplane but once thus equipped a line can handle many more additional jet aircraft without much further investment in ground equipment thereby bringing the cost per aircraft down. United's ground equipment list for its DC-8 fleet includes 25 tractors at $30,000 each, 31 turbo-compressor starters at $20,000 each, and seven "peach-pickers" for servicing the tall vertical fin at $17,000 each.

A total of some 80 types of ground equipment had to be purchased.

Baggage Handling

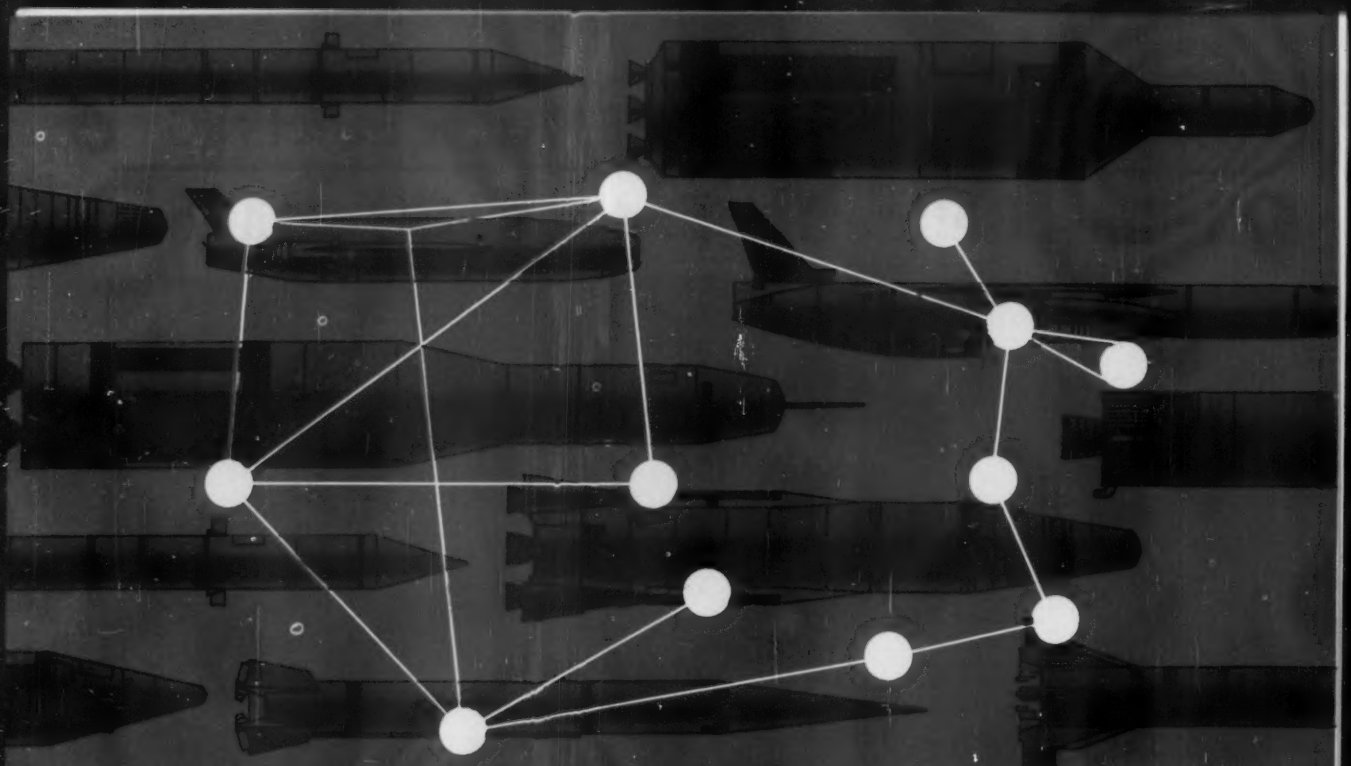
Improved baggage handling is one of the important contributions to come along with the jet airliners. United put $100,000 per aircraft into its baggage preloading scheme. This figure does not include the cost of the preloaded baggage baskets and the carrying wagons. It was necessary to buy 800 baskets at $500 each and 730 wagons at $250 each. Mentzer said it will take eight or nine years to amortize these expenditures but competitive appeal and other intangibles make the investment well worth the price. It has produced a startling improvement in baggage service.

Mentzer cited a need for more and better checkout and trouble-shooting equipment. He said missile and military aircraft technology should provide an ample basis for the development of such equipment.

DC-8 Performance

Mentzer said DC-8 performance problems are far less severe than once reported. In line with frequent Douglas practice, the DC-8 was designed larger than optimum for existing engines, fully anticipating that it would be re-engined to realize its full growth potential. Lifetime of the airframe is expected to be such that it will be able to capitalize on engine developments for many years.

W. E. Rhoades, United manager of flight engineering, made a brief comparison of United and Trans World Airlines operations between San Francisco and New York. He said that at the outset of DC-8 service, United flew optimum altitudes and required 12 min. more to make the eastbound flight than TWA's Boeing 707. United is now



SYNISTANAI "to place together." Hallamore has placed together outstanding engineering talents and facilities to provide complex ground support systems for major aircraft, missile, and space projects. Current contracts include special factory test consoles for the Discoverer; pop-up range instrumentation for the Polaris; static firing instrumentation for the Titan; production of field and factory automatic test equipment for the Sergeant; automatic checkout for Atlas sub-systems; range safety "sky-screen" TV for AFMTC; drone-borne TV display and checkout system for U.S. Army Signal Corps. The Hallamore "Synistanai" capability is available to handle your ground support requirements. Write Hallamore Electronics Company, 714 N. Brookhurst St., Anaheim, California. TWX: AH5279... a division of The Siegler Corporation.

ENGINEERS: FOR IDEAL WORKING CONDITIONS WITH A DYNAMIC, CREATIVE ORGANIZATION, ADDRESS RESUME TO CHIEF ENGINEER

HALLAMORE

94

flying constant altitudes and has cut the difference to seven minutes. Rhoades said United has been carrying a 17,500 lb. fuel reserve, while TWA has been carrying a 13,000 lb. reserve.

Capt. J. B. LeClaire of TWA flight operations research and development challenged Rhoades' statistics. While having no comparable figures, LeClaire said statistics for westbound flights would show a bigger advantage for TWA than the eastbound figures selected by Rhoades. He said United is operating at a higher and less economic power level than TWA 707s. TWA will widen its advantage over the DC-8 after the first engine overhaul, he said. At that time, TWA will install the same later model Pratt & Whitney JT3 used in the DC-8. LeClaire criticized Rhoades for violating a confidence. He said Rhoades' figures were based on information privately exchanged by the two airlines.

Necessary Conservatism

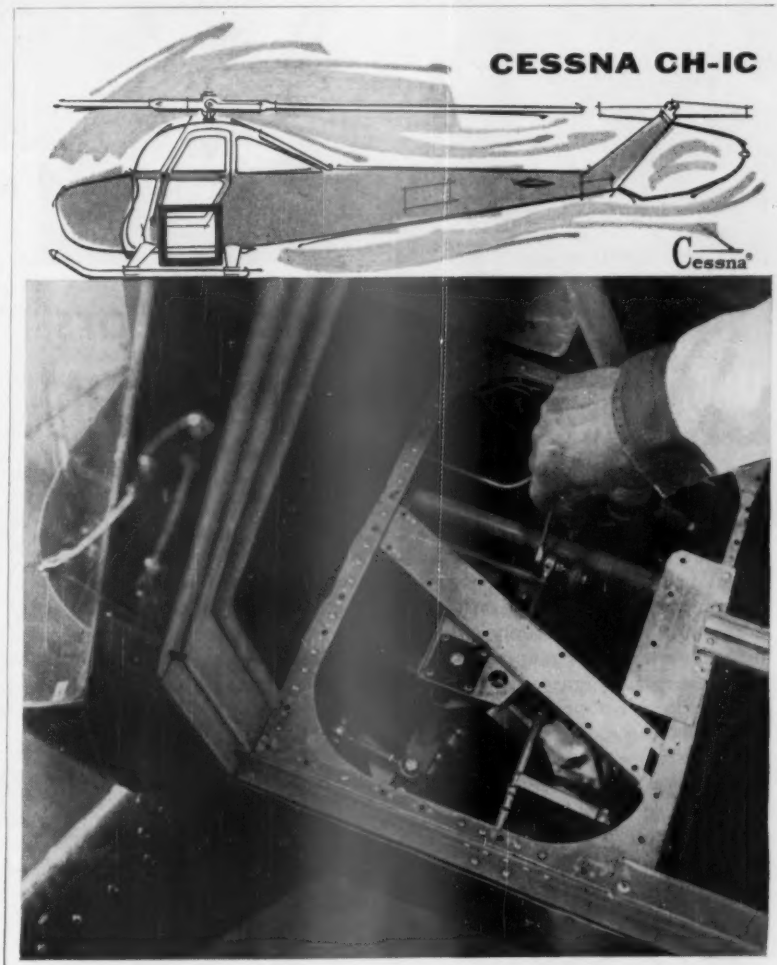
LeClaire said TWA is finding the 707 an easy airplane to fly but a slight problem in dispatching because of the conservatism necessary in operating a new high-performance airplane. Until recently, few TWA pilots had logged 100 hr. in type. Therefore, they have been required to use instrument minimums of 300 ft. and ¾ mi. compared with the 400 ft. and one mile allowed to pilots with over 100 hr. in type. This has meant more cancellations and delays than would ordinarily occur.

During the current first winter of jet operation, TWA will continue to fly conservatively when runway conditions are marginal. Inevitably, this will affect schedule performance. TWA like other carriers has arbitrarily padded operating margins for the sake of safety. This will close some fields to airline operation which are legally open. For slush on the runway up to ½ in. thick permissible gross weight will be cut by 5%. No takeoff will be permitted with slush over ½ in. thick. Runways cited by LeClaire where runway length and other factors are apt to cause problems are Kansas City Municipal, ILS runway at St. Louis and Runway 10, back course at Pittsburgh.

Terminal area traffic control problems which TWA anticipated have not yet materialized. It was thought probable that some system would be needed to control orderly departure from the ramp to avoid lengthy holds at the runway before takeoff. High altitude holding pattern and approach clearances from the high pattern through a rapid descent penetration to the outer marker were also thought necessary. However, approach procedures have followed about the same routings and low altitude holding patterns that are used with piston aircraft, though descents from cruising altitude are more rapid. Departures from the ramp are also done conventionally but New York departures present a problem.

LeClaire said "We carry 50% more fuel for taxi and ground hold at Idlewild than at other airports. We still think some better system must be devised to handle this problem. Our average ground time at Idlewild is about 15 min. but we have experienced delays of 30 to 40 min." LeClaire commended traffic control personnel in the Chicago area for their extensive use of radar vectoring to expedite approach and departure of jet flights.

LeClaire said, "One problem which concerns us en route is the lack of positive separation from military aircraft on the radar-controlled jet airways. Our understanding is that the present system depends on transponder operation in the military aircraft, yet this operation is not required to be confirmed by the controller in the area involved. Thus a military pilot could take off, check his transponder operation with his home base and subsequently lose it without his knowledge and proceed across a jet airway VFR without benefit of radar following. A number of pilot reports of aircraft in their vicinity unknown to the radar controller substantiates this concern."



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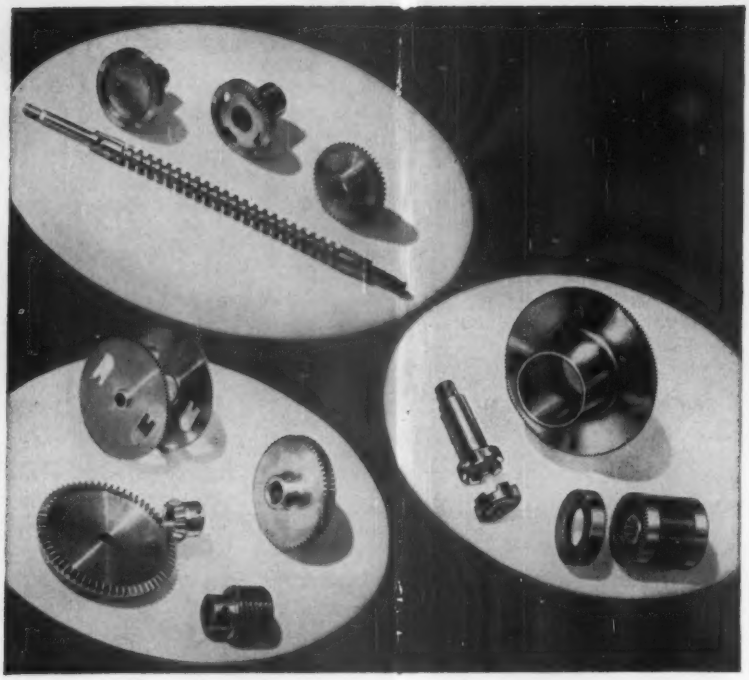

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Modified BB-152 Nears First Flight

Mk. 2 modification of the Baade BB-152, East German four-turbojet transport (AW Mar. 23, p. 58) will make its first flight soon, operated by a four-man East German Deutsche Lufthansa crew.

Performance data for the three versions of the Mk. 2 passenger plane, all powered by four 6,950-lb. thrust Pirna 014 engines with 12-stage axial compressors, includes:

- **48-passenger**—empty weight 62,060 lb., fuel, 27,230 lb., payload 13,230 lb., takeoff weight 102,530 lb., maximum landing weight 89,300 lb., and range 1,552 mi.
- **57-passenger**—empty weight 62,370 lb., fuel, 21,870 lb., payload 13,865 lb., takeoff weight, 98,100 lb., maximum landing weight, 89,300 lb., and range 1,242 mi.
- **72-passenger**—empty weight, 62,660 lb., fuel, 22,380 lb., payload, 17,480 lb., takeoff weight, 102,530 lb., maximum landing weight, 89,300 lb., and range, 1,242 mi.

Takeoff run at 102,530 lb. is 3,231 ft.; takeoff distance over a 35 ft. obstacle is 4,314 ft.; landing distance from a 49 ft. altitude at 77,170 lb. landing weight is 4,590 ft., and landing run from touchdown is 2,263 ft.

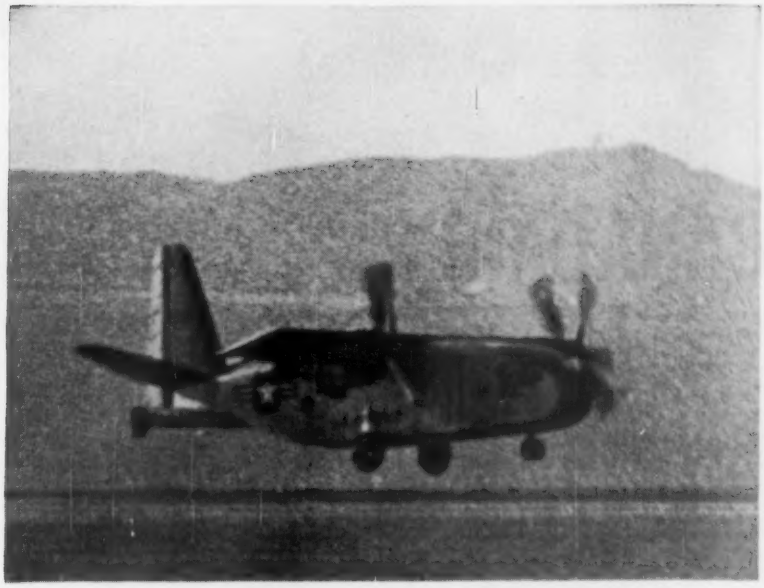
An East German official says that one of the BB-152/II's main virtues is that it can take off and land from runways less than 1,000 meters (3,280 ft.) long.

A4Ds to Incorporate Rocket Ejection Seat

China Lake, Calif.—Navy-Douglas El Segundo rocket-assisted personnel ejection catapult (RAPEC) has been developed and tested and will be installed in A4D aircraft now serving with the fleet.

The rocket portion of the ground-level to high altitude escape system was developed by Naval Ordnance Test Station for Navy Bureau of Ordnance, while the seat was developed by Douglas for Navy Bureau of Aeronautics.

The system features a solid propellant rocket fastened to the pilot's seat, operating as a piston inside another tube which is attached to the airframe. A unique part of the propulsion development is a gas booster tube contained inside the solid propellant. This becomes, in effect, a booster within a booster. The small tube has its own propellant charge, and this is what serves to boost the seat-pilot clear of the airframe. After the small tube is done firing, and when the pilot and seat are clear of airframe, then the large



Hiller X-18 Makes Runway Liftoff

Hiller X-18 tilt-wing research vehicle which has successfully completed its initial flight (AW Dec. 7, p. 35) is shown on runway at Edwards AFB, Calif.; plane did not actually fly on this run, but was pulled off the runway for a short distance and then landed again. Flight test work will be conducted with wing fixed in horizontal position and, following this, will enter the tilted test phase, progressing to full vertical takeoff.

propellant tube ignites and sends the pilot and seat to 200 ft.

The system works in four stages—first, the propellant gases push the seat out of the aircraft; second, the rocket projects pilot and seat 200 ft. above his aircraft; third, bladders inflate by compressed gas to separate the pilot and seat; fourth, the parachute opens to lower the pilot.

RAPEC sends the pilot out at an angle of 47½ deg. (with respect to the plane's fuselage reference line) at an acceleration of 13g for 0.4 sec., well within normal tolerances. Seat ejection system weighs 79 lb., some 50% lighter than average ejection systems.

China Lake program, which has been underway for two years, has successfully completed a number of 680 mph. ejections on the NOTS supersonic sled track, although Navy does not recommend ejection at that speed.

A version of RAPEC, specially adapted to the installation, is used as the upward ejection system on the Lockheed F-104C Starfighter, from which a Tactical Air Command pilot made the first successful upward escape in October, near George AFB, Calif.

PRODUCTION BRIEFING

General Electric YJ85-5 turbojet engine has made its first flight tests in an instrumented pod carried by a Convair F-102 testbed (AW Oct. 19, p. 37). Tests of steady state and afterburning performance were conducted at altitudes up to 42,000 ft. Engine will power the twin jet Northrop N-156F.

Aeroproducts Division of Allison will design a new 7½-ft. twin-bladed propeller for the 250 hp. Allison T63 turboprop engine, under a U.S. Air Force contract.

Douglas Aircraft Co. has established an Advanced Research Organization under over-all direction of A. E. Raymond, senior vice president-engineering. Charles R. Strang will head the group.

Boeing Airplane Co., Wichita, Kan. will study the effects of vibration on space vehicle crews under a $110,000 Office of Naval Research contract. A flight simulator capable of vibrating a crewman at up to 30 cps. in his seat at varying g loads will test the ability of humans to perform flight tasks under vibrational conditions.

Fruehauf Trailer Co., Delphos, Ohio, will build 111 antenna carriers for the Army Hawk surface-to-air missile under a $460,000 contract. The M-514, a one-ton, single-axle chassis, will carry electronic ground support equipment for the missile.

Aeronutronic, a division of Ford Motor Co. has established a field office in Huntsville, Ala. The company is engaged in development of Shillelagh, Army surface-to-surface missile.

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Canadair Forty Four, photographed in flight November 15, 1959

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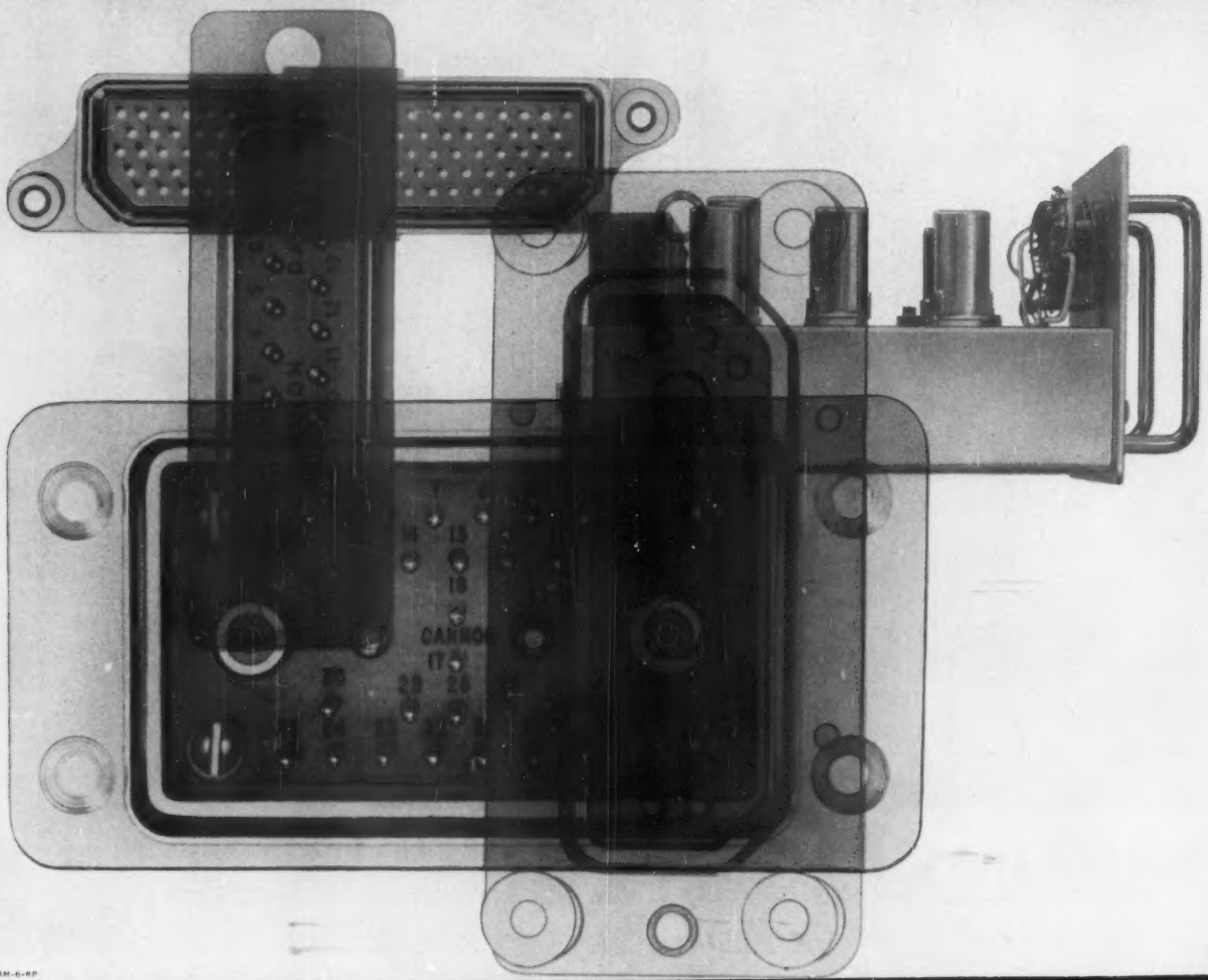


CAM-6-RP

British Accident Investigation Report:

Airline's Policy Scored in Viking Crash

(Following is a report to H. A. Watkinson, Minister of Transport and Civil Aviation, on a public inquiry, conducted by H. J. Phillimore, into the crash of an Independent Air Travel, Ltd., Viking transport Sept. 2, 1958, north of London Airport. Three crew members and four persons on the ground were killed).

Juliett Echo, a Viking aircraft owned and operated by Independent Air Travel, Ltd., (hereinafter called the company), took off from London Airport at 0554 GMT on Tuesday, Sept. 2, 1958, with a crew of three for a flight to Nice and thence via Brindisi to Athens and from there to Lod Airport at Tel Aviv in Israel. At 0632[1]—rather less than 40 min. later—the aircraft crashed into houses at Kelvin Gardens Southhall, about three miles northeast of London Airport, causing considerable damage to property, the deaths of all her crew and of four members of the public.

Prior to my inquiry into the causes and circumstances of this accident an inquest had been held on the deaths so caused by a deputy coroner for Middlesex. In the course of his inquest the deputy coroner thought it right to conduct an inquiry into the causes and circumstances of the crash. His inquest took a considerable period of time to complete and in the course of it many of the witnesses who appeared before me were subjected to lengthy examination and cross-examination. It is not for me to comment on the duplication of proceedings which has resulted, or the inconvenience suffered by members of the public required to attend both proceedings, but I feel bound to point out that a witness who has once been subjected to cross-examination on his evidence as to a particular incident is not unnaturally likely to be more wary and less amenable on a second occasion to cross-examination in regard to the same incident.

This tendency is not likely to be diminished if his or her evidence on the first occasion was subjected to criticism. In short, much of the evidence put before me was no longer fresh—quite apart from the time which had elapsed since the accident, many of the witnesses were thinking of the question which might follow a truthful answer rather than of what in their best recollection was the truth. These conditions have rendered my task less easy than it would normally have been.

Juliett Echo took off from Runway 10R at London Airport at 0554 hr. Her crew consisted of Capt. Mayger, Mr. Altena as first officer and Mr. Howard as engineer officer. The load comprised two Bristol Proteus engines properly loaded and secured on stands. There was little wind but conditions were foggy up to about 1,000 ft., at which height aircraft enjoyed bright sunshine. There is no certain evidence as to who occupied the pilot's seat on the port side but I have little doubt on the totality of the evidence that it was Capt. Mayger, with Altena in the co-pilot's seat on his right. I accept the evidence of Mr. Searle who saw Juliett Echo at the threshold of the runway and observed a man who must have been Howard get out and walk across the front of the aircraft where he stood for half a minute and watched the starboard engine before climbing back into the aircraft. He was looking for signs of an oil leak from that engine.

On leaving London Airport Juliett Echo was cleared to Epsom at 2,000 ft., thence to Dunsfold at 4,000 ft. and then to climb away to 7,500 ft. at Seaford out of the airway. The aircraft duly followed these instructions until at about 0609 hr. it reached a point some 10 mi. southeast of Dunsfold. At this point Capt. Mayger informed London Airways that he had engine trouble and wished to return to Blackbushe and asked for the weather there. In reply he was told that he could return to Dunsfold at his present altitude which he confirmed as 7,000 ft. adding in answer to the question whether he was able to maintain altitude that he was able to do so.

At 0611 he was asked whether he had feathered one engine, to which he replied that he had only throttled it down. Soon afterwards, told that he could descend to 5,000 ft. he confirmed that he was proceeding to do so, after which he was instructed that Blackbushe required him at their beacon at 3,000 ft. or over, which message was acknowledged.

It is to be observed that the above messages from the aircraft and Capt. Mayger's replies to questions indicate no sort of

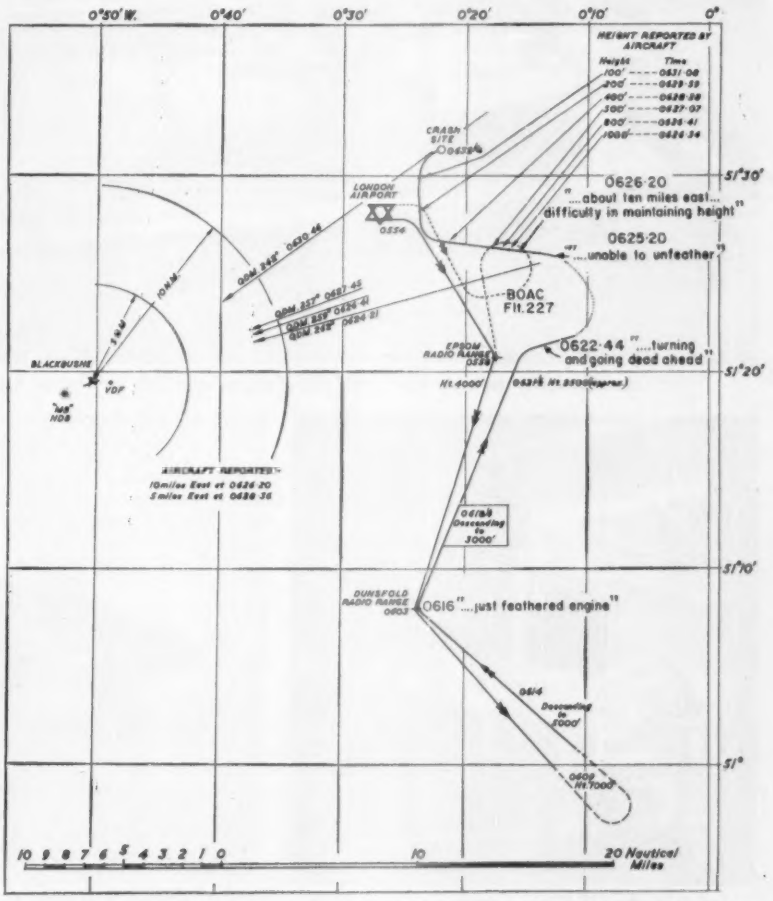
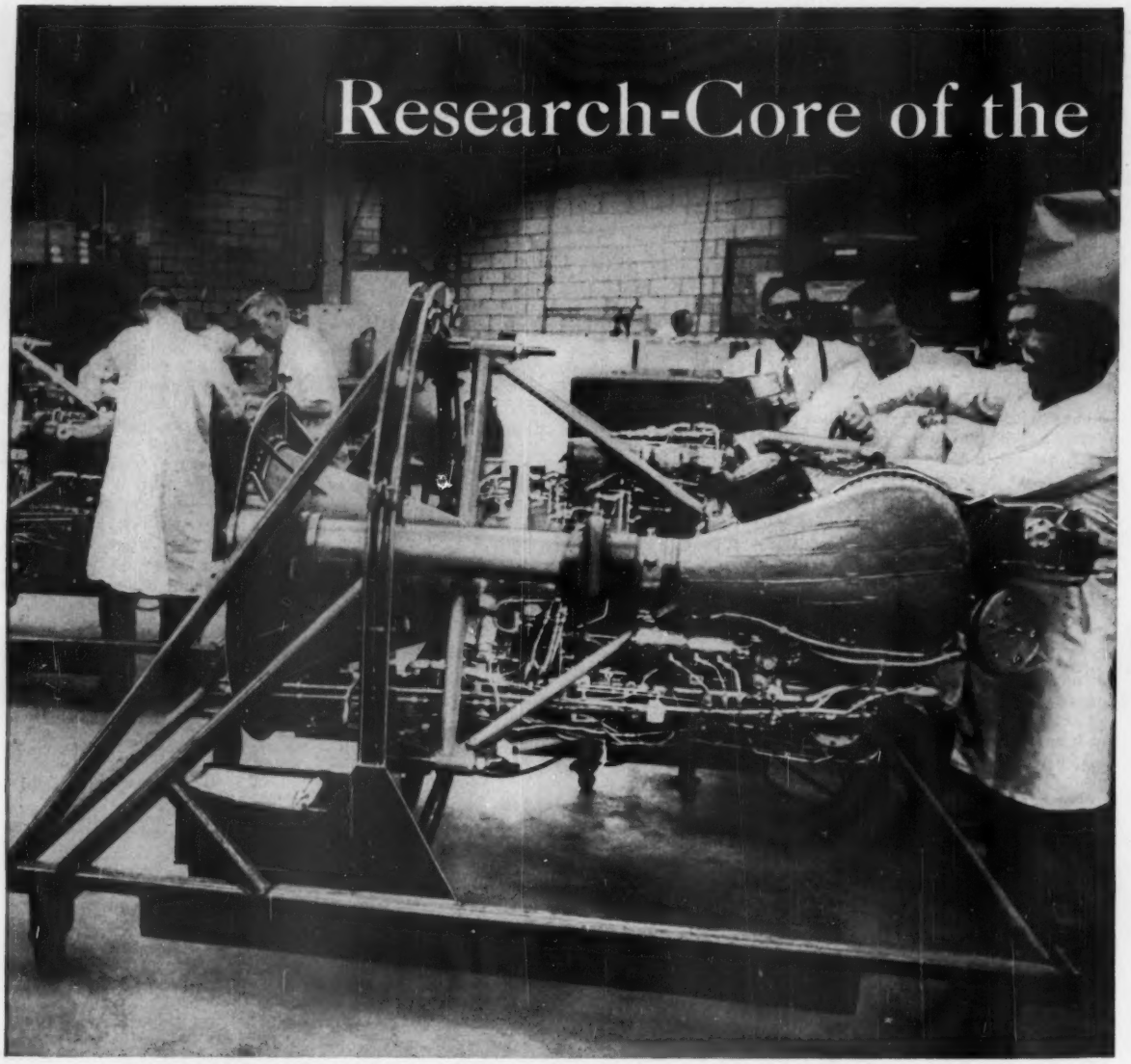


CHART shows Viking's flight path after takeoff from London Airport, transmission points.

(Throughout this report times quoted in relation to any flight are quoted by reference to Greenwich Mean Time (GMT). Unless otherwise stated times referred to in the narrative of events on the ground are taken direct from the evidence of the witnesses and are accordingly British Summer Time (BST).

Research-Core of the



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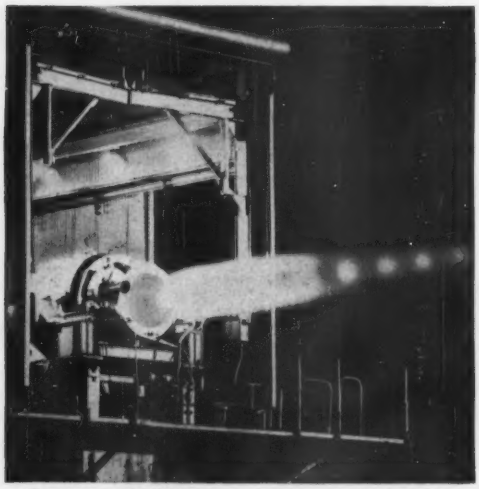

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emergency in an aircraft designed to fly and if necessary climb on one engine: nevertheless by 0615 the approach controller at Blackbushe, warned of the position by London Airways, had taken the appropriate action in case of emergency including a warning to the United States Naval Unit available at Blackbushe to close up so as to be ready to give Ground Control Approach (GCA) directions in case of emergency.

Engine Feathered

At 0616, Capt. Mayger informed London Airways that he had just feathered the starboard engine—it had been throttled back for at least five minutes. He added that he would be starting it again for his landing at Blackbushe. At 0617 London Airways, confirming that he had passed Dunsfold, instructed him to set course for Blackbushe Beacon and told him to contact Blackbushe, which he would do by changing the frequency of his radio/telephone. At this point the aircraft ought to have taken up a northwesterly course for Blackbushe beacon but instead, directed its course to the east of north towards Epsom. This was an error in heading of some 70 deg.

Just after 0617, Capt. Mayger spoke to Blackbushe Approach who acknowledged and cleared him to the Beacon at 3,000 ft. —he was given the weather at Blackbushe and told that the QFE was 1001 which, if he set it on his instruments as he would normally have done, would have had the effect that at Southall he would have been 100 ft. up when his instruments showed the altitude at zero.

At 0620 Capt. Mayger repeated to Blackbushe that he was flying on one engine but would be starting the other for his landing.

Wrong Course

About this time the air traffic controller at London Airport, who had controlled the outward flight and had handed over the aircraft to Blackbushe control on its return to Dunsford, saw on the radar that Juliett Echo was apparently on the wrong course and approaching Epsom. The Epsom stack controller who was informed, was particularly concerned as a British Overseas Airways Corp. aircraft was at this time obliged to overshoot London Airport as a result of the fog. Accordingly he spoke to Blackbushe, telling the controller there that Juliett Echo seemed to be approaching Epsom and asking him to check her position before letting her descend below 3,000 ft. At the same time he warned the BOAC aircraft, then at 2,000 ft., to look out for a Viking on one engine. It will be realized that he had no certainty that the aircraft appearing on the radar screen was Juliett Echo and that he could no longer speak direct to Capt. Mayger, who had changed his frequency to that of Blackbushe.

At 0622 Blackbushe asked Juliett Echo to confirm that it was on course for Blackbushe Beacon, to which Capt. Mayger replied: "I have your beacon, turning and going dead ahead"; meaning presumably that he was turning to the west. Immediately afterwards, when told that it was reported he was heading for Epsom, he said he would "re-tune". Probably a minute before this exchange Juliett Echo was sighted by Captains Jenner and Hart flying the BOAC aircraft. They put its height at about 2,500 ft. and its course roughly northeast.

At 0624 Capt. Mayger asked for a QDM —namely his magnetic course to Blackbushe Beacon—this was given and at 0625 he was offered GCA, the crew having just closed up at Blackbushe.

At this point came the first indication of difficulty—Capt. Mayger stated:—"I'll take GCA please. I have one engine feathered and I don't seem to be able to unfeather at the moment." In fact, as was discovered after the crash, his starboard feathering motor had been burnt out.

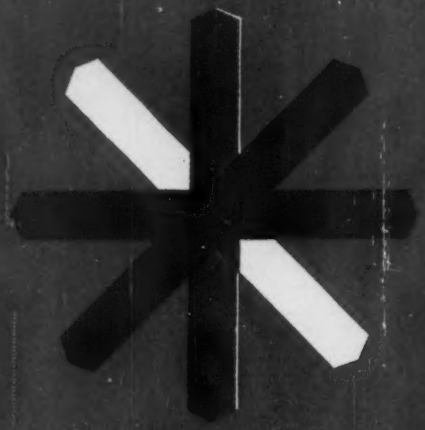
At 0626 he gave his position as 10 mi. east of Blackbushe and added the ominous message "and having difficulty maintaining height." He then gave his height as 1,000 ft. which he immediately corrected to 800.

Mayday Signal

A series of messages followed in which the captain asked for and was given QDMs, while the GCA at Blackbushe attempted without success to get in contact with Juliett Echo. At 0627 Capt. Maygar reported 500 ft. and at 0628 when he stated his distance as five miles from Blackbushe he gave a height of 400 ft. In fact at about this time the aircraft was 20 mi. away and veering to the north; flying on the port engine only it seems clear that the pilot was beginning to lose asymmetric control. At 0630 Altena appears to have taken over the R/T, giving the height as 200 ft. After the series of QDMs to which Juliett Echo could no longer correct her course Altena reported at 0631 that she was "almost on the deck" and soon after that she was "over a town." Finally he gave the Mayday signal at 0632.

In considering the messages I have detailed and the facts disclosed, certain obvious factors deserve recording. The aircraft when it first reported trouble was at 7,000 ft. and the captain had confirmed his ability to maintain height. He was not unduly concerned, as he did not at first feather his engine and, indeed, until a late stage planned to restart it for his landing. At the time that he took the wrong course at Dunsfold he was in bright sunshine and at a height of at least 3,000 ft. Although not cleared for any lower height he apparently descended to 1,000 ft. without informing Control, but doubtless in the belief that he was very close to Blackbushe. The first real indication of anxiety came at a height of about 1,000 or 800 ft., at which he would have been entering the fog layer, and when he found himself unable to unfeather his starboard engine. By this time he knew he was off course, but was in fact many miles further to the east than he supposed. Thereafter it looks as though the aircraft lost height steadily until the final veer to starboard. It was less than three minutes before the crash that he handed over the R/T to his co-pilot.

A number of witnesses were called who saw the aircraft in the final stages of its flight and one boy of 14 engaged in delivering newspapers who saw the final dive with the starboard wing down. These witnesses, with one exception, were accurate and helpful. The exception was a cafe proprietor living about a mile north of the scene who on hearing of the crash immediately tele-



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URGENT PROBLEMS RELIABLY SOLVED

phoned the newspapers and obtained money for his account, whereas in fact I am satisfied that he had not seen this particular aircraft at all. With this exception the eyewitnesses confirmed that the aircraft was flying on the port engine only, the starboard engine being feathered—facts which (despite the fire which followed the impact) were also shown as a result of the examination of the wreckage by the officers of the Accidents Investigation Branch.

Before seeking to analyze the evidence as to the events which preceded the flight and which may help to explain this disaster it is convenient to record some general observations:

The company which owned and operated this aircraft, together with some six or seven others, had flown a total of about 30,000 hr. at this date, and without fatal accident. At the time of the accident it was operating from Blackbushe as an advanced base and where its offices consisted of three caravans, the main base being at Hurn Airport near Bournemouth. The managing director, whose interest in the company terminated on the first day of my inquiry, was a Capt. Kozubski. The company's operations were in fact dictated by him, although there were other directors, including Capt. Lloyd, the operations manager, and Mr. Norman Ebbutt, the technical director, the latter's responsibility being chiefly confined to questions of maintenance of the aircraft.

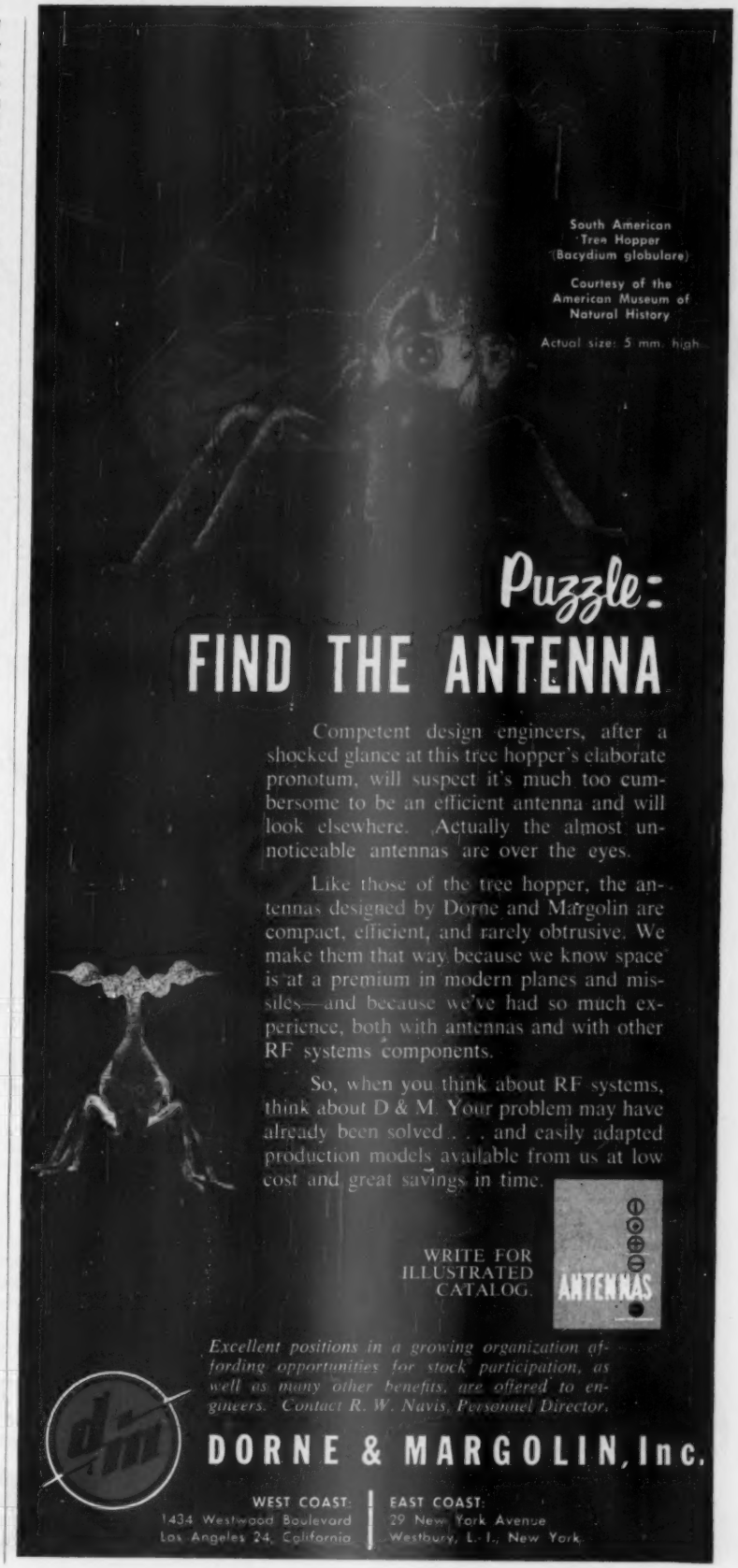
Airline Employees

As sometimes happens in a small company in this field the personnel were largely recruited from men who, for one reason or another, had formerly been employed by the corporations or the larger companies but who had lost that employment, or from men who would scarcely have been eligible for employment with a company of established reputation. It must be recognized that with employees so situated it is not difficult for employers, who are not unduly concerned to observe the regulations, to drive their employees and, if considered desirable in the financial interests of the company, to induce them to disregard the regulations designed to ensure safety in the air.

In the light of the facts hereinafter set out it is right to record that a full and searching report into the affairs of this company made by the officers of the MTCA in December, 1958, shows that since this accident the company has taken great pains and spent a good deal of money in putting its affairs in order, with the result that its organization now bears favorable comparison with that of other larger companies and so that, if it is given a chance to do so, it is now able to provide a safe and proper service.

I propose to review the topics which bear upon this crash in the following order: first the history and condition of the aircraft, its maintenance and handling prior to the flight; secondly the load carried; thirdly the experience and fitness of the crew, also the training methods of the company; and finally the probable effect of the foregoing on the events of the flight described above.

This aircraft was built in 1946 by Vickers Armstrongs, Ltd. It was powered by two


South American
Tree Hopper
(Bacydium globulare)
Courtesy of the
American Museum of
Natural History
Actual size: 5 mm. high
Puzzle:
FIND THE ANTENNA
Competent design engineers, after a shocked glance at this tree hopper's elaborate pronotum, will suspect it's much too cumbersome to be an efficient antenna and will look elsewhere. Actually the almost unnoticeable antennas are over the eyes.
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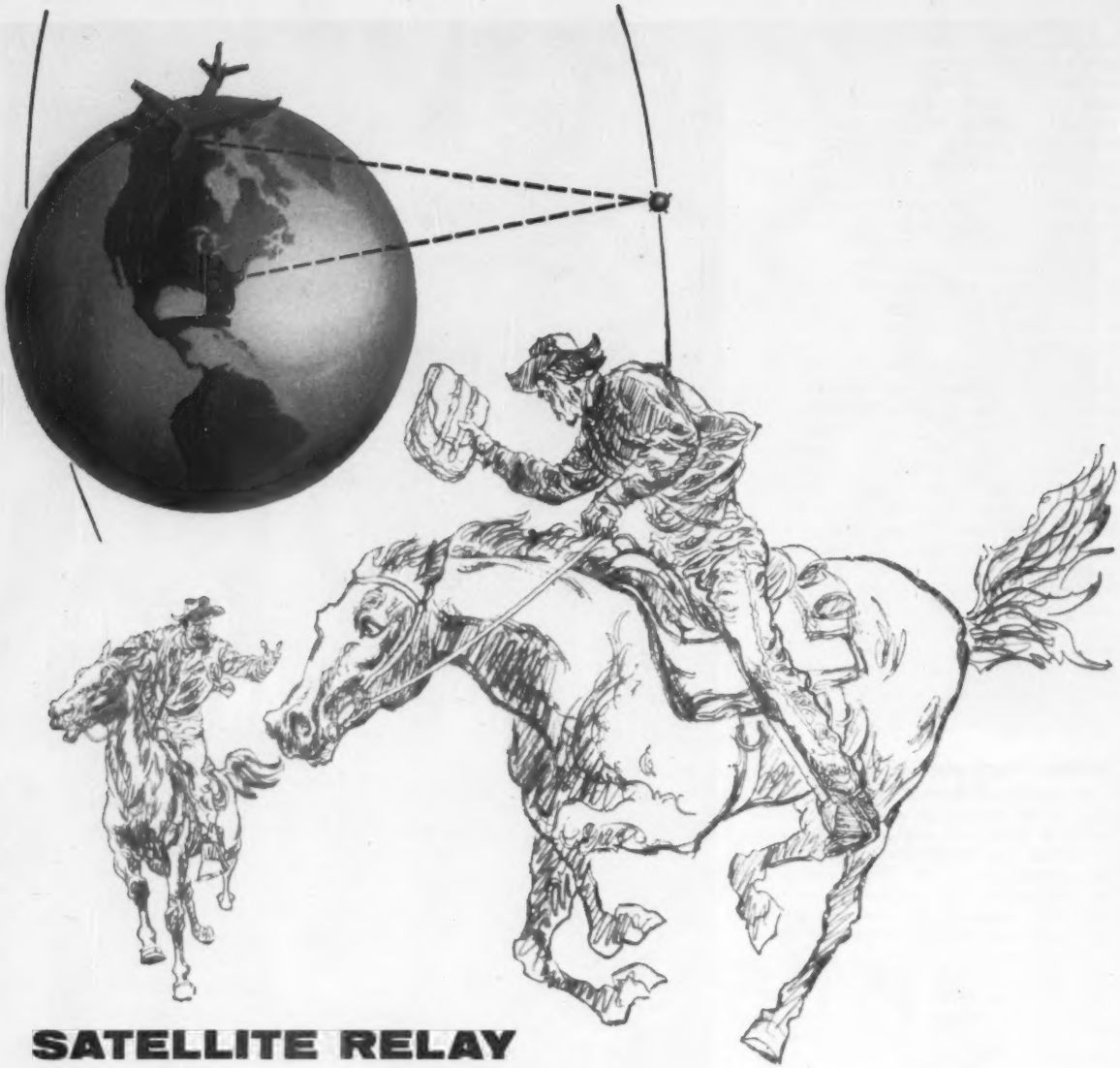

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AVIATION CORPORATION

Bristol Hecrules 634 engines driving Rotol four-bladed all metal propellers. It was used variously by the Royal Air Force and by the Ministry of Supply, chiefly on research and experimental flight tests until April 1957, when it was placed in storage, having flown a total of only 1,535 hr.

Juliett Echo was purchased in September, 1957, by the company which obtained a Certificate of Registration as owners and thereafter operated the aircraft, which had flown a total of only 2,319 hr. at the time of the accident.

The Certificate of Airworthiness was renewed on Mar. 6, 1958, and was valid until Mar. 5, 1959, and consequently at the time of the accident. Since renewal of the certificate the aircraft had flown 783 hr.

At the time of the accident, each engine was well within its approved life: the port engine had flown 1,085 out of the permissible 1,250 hr. since overhaul in January, 1954, and the starboard engine 964 hr. since it was overhauled in May, 1954.

The propellers were also within their approved running life of 1,280 hr. since overhaul, the port propeller having run 1,158 hr. since February, 1954 and the starboard 1,036 hr. since November, 1954. They had, however, been in use in excess of their stipulated calendar life of three years from last overhaul, the excess being 18 months in the case of the port and nine months in the case of the starboard propeller. In failing to observe the requirement as to calendar life, the company had in fact erred together with the surveyor of the Air Registration Board. In the light of the condition of the propellers as disclosed by their examination after the crash it is quite clear that this error had no causative effect on the accident and that the condition of the propellers was such that if an application had been made there was no reason why the calendar life should not have been extended.

Feathering Impossible

Despite the scattering of the wreckage and the fire which followed the crash, the evidence of the officers of the Accidents Investigation Branch, together with that of representatives of the Bristol Aircraft Co. and of Rotol Propellers, Ltd., proved that the engines were in sound working order, also the propellers, and that the starboard engine showed no signs of lack of lubrication. The evidence was clear that there was no mechanical failure of either engine or either propeller. Equally, however, it was established that the starboard feathering motor was burnt out and that this had occurred prior to the crash, a fact which explains the inability of Capt. Mayger to unfeather this engine. The destruction of the sump was so complete that it was impossible to ascertain the source of any oil leak.

Some idea of the intensity of the company's activities and of the user of this aircraft is perhaps important as illustrating the need for a first class maintenance organization:

• **On Tuesday**, Aug. 26, 1958, Juliett Echo left Blackbushe at 1350 hr. for London Airport, Lyons and thence to Nice, where it arrived at 2200 hr. GMT.

• **On Wednesday**, Aug. 27, it left Nice at 0845 hr. flying to Rome and thence to

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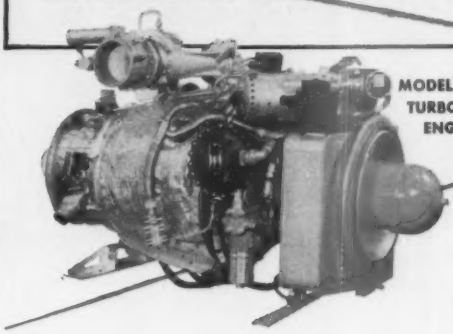

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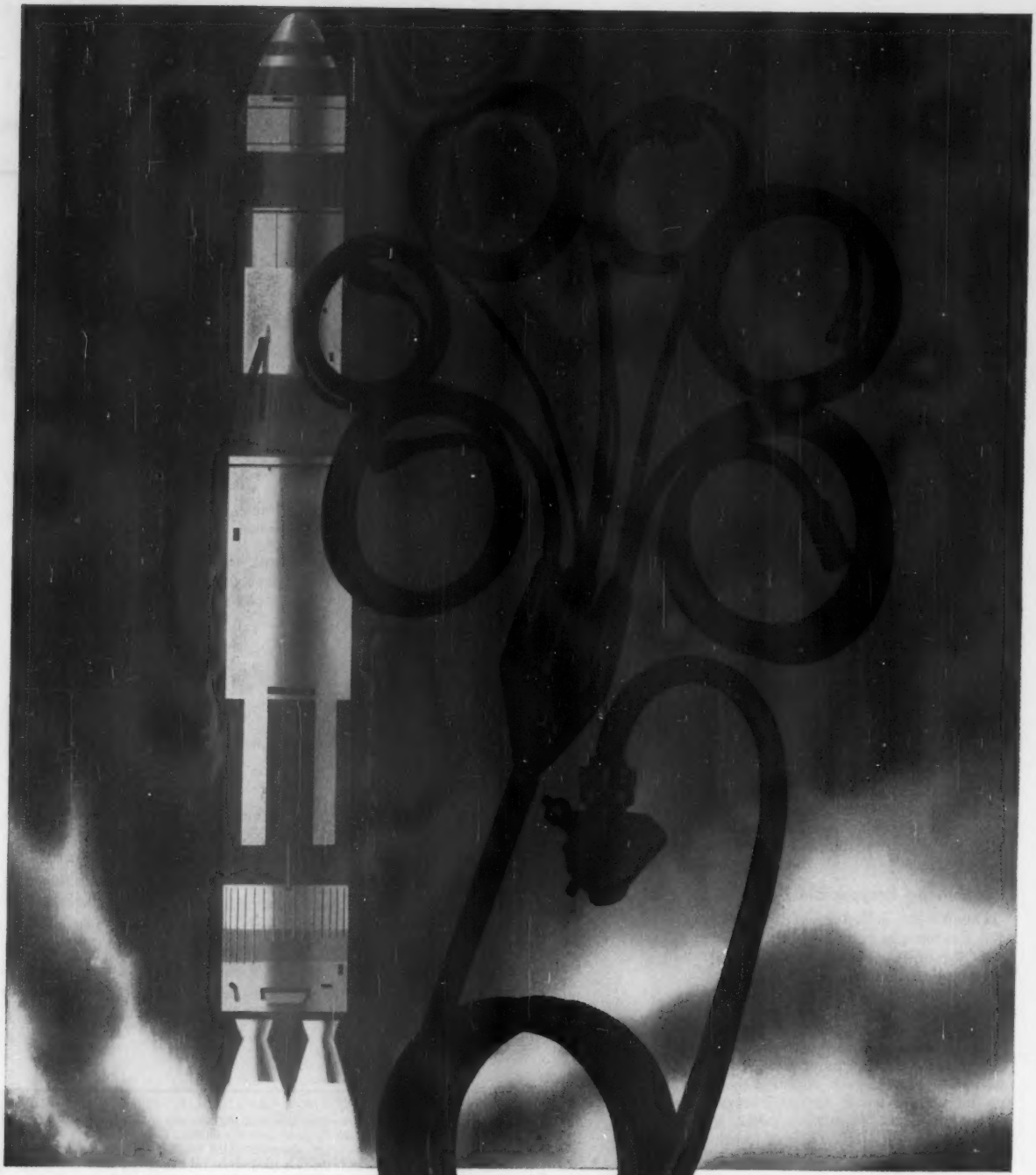

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Athens and from there to Lod Airport, Tel Aviv, arriving at 1835 hr.

• **On Thursday,** Aug. 28, the aircraft left Lod at 1625 hr. and flew to Nicosia in Cyprus, thence to Athens, arriving at 2145 hr.

• **On Friday,** Aug. 29, it left Athens at 0805 hr. for Brindisi, thence to Nice and from there to London Airport, where it landed at 1930 hr.

• **On Saturday,** Aug. 30, Capt. Mayger and Altena took off from London Airport at 1325, landing after 10 min. flight at Blackbushe. Three hours later, Capt. Mayger, with a different crew, took off and flew to Le Bourget, thence to Nice and then back to Blackbushe, landing at 0230 hr. on the morning of Sunday, Aug. 31.

At 0745 hr. that morning (namely five and a quarter hours later) Juliett Echo took off again piloted by Capt. Kozubski. He flew to Oporto, thence to Lisbon and from there via Bordeaux back to Blackbushe, landing at 0050 hr. on the morning of Monday, Sept. 1, 1958.

Thus in six days the aircraft had been actually in the air for 44 hr. 45 min.

Malfunction Noted

On the morning of Monday, Sept. 1, Capt. Kozubski notified three snags, the second of which must be recorded:—

"Strb. engine C.S.U. oil leak also surging, suggest change C.S.U. (or seal)."

The C.S.U. is an abbreviation for the "constant speed unit," a finely tooled part fitted on top of the engine close to the propeller and which serves to maintain the revolutions of the propeller at a constant speed.

The organization of the company provided for the presence at Blackbushe at any time of either one or two men licensed for maintenance work on engines, together with a number of unlicensed fitters. Likewise, there were one or more men licensed for the maintenance of the airframe and two men, of whom only one was licensed, to maintain radio equipment.

The aircraft was due to leave Blackbushe about mid-day on Monday in order to fly to London Airport to load the two Proteus engines, it being intended that it should leave that evening for Nice on its way to Lod Airport at Tel Aviv. Accordingly, the time left for maintenance was strictly limited.

The company's engineering department did not at this date possess an approved inspection organization and accordingly any work of repair or maintenance required certification by a licensed engineer whether it involved engines, airframe or radio. The three licensed engineers available on Monday, Sept. 1, were Cuccaro (engines), Hardy (airframe) and Atkins (radio). It is convenient to deal with each component in turn.

Repairs Made

As soon as the aircraft was available in the early hours of the morning two fitters, neither of whom was called as a witness, and who were working under Cuccaro, began to carry out a Check I on the starboard engine—the snags being left for rectification in daylight. The Check I on the starboard engine was thus completed by 0700 hr. when two fresh fitters (Ball and Shields) reported for duty. One of these carried out a Check I on the port engine while the other proceeded to deal with the snags.

The latter fitted a new stalk seal to the starboard propeller and removed the C.S.U., replacing it with another taken from store, together with a new gasket, this being fitted at the base of the C.S.U. where it connects with the engine.

A C.S.U. can itself be taken apart, the two sections being sealed by a thin rubber band of irregular shape fitted into a fine slot in the upper unit. Cuccaro stated in evidence, and I accept, that he had never seen a C.S.U. taken apart so as to expose the rubber band or seal, while the company's approved maintenance schedule rightly stipulated that if a C.S.U. was taken to pieces so as to expose the seal it should not be reaffixed to the engine until it had been rig tested on a bench. The C.S.U. fitted on this occasion and taken from store had been thoroughly overhauled and tested.

The work to the engines completed, they were given a ground run by Cuccaro, who in the course of this ground run carried out a full feathering test on each engine. To carry out this test involved firstly moving a lever and secondly pressing in a button situated in the cabin above the head of the pilot, so bringing into play a small electrical motor. The button being depressed for some 10 sec. would allow the motor to feather the propeller, whereupon the button should be released, and, if its spring failed to cause it to spring out on release, should be pulled out. If allowed to remain depressed, the motor would continue to run and would, if left in for over seven minutes, burn itself out, with the result that it would no longer be available if it was desired to unfeather, the drill for which required the button to be depressed once again.

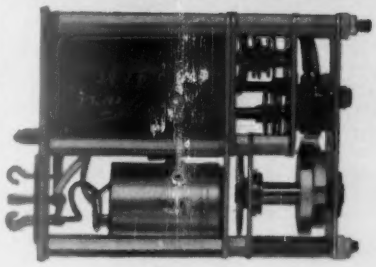
The work on the engines detailed above was in due course certified by Cuccaro, who in addition dipped the petrol tanks and estimated their contents at 230 gal.; he also checked the oil tanks, each of which he found to contain between 11 and 12 gal.

Work Supervision

In considering the accuracy and competence of this work there are several factors to be borne in mind. Much of it, and in particular the Check I on the starboard engine, was carried out by an unlicensed fitter between 2 and 7 a.m. I doubt whether Cuccaro could have effectively supervised this work. On the other hand the work of renewing the stalk seal and fitting a new C.S.U. and gasket was performed in daylight by a man who came fresh to his work, and its efficiency, certainly as regards the cylinder stalk seal, was corroborated by subsequent events.

In carrying out a complete feathering test on each engine Cuccaro was in fact departing from the requirements of the approved maintenance schedule of the company, which prescribed a snap check only for a Check I. This requirement was proper, since a full check if carelessly or too frequently conducted might tend to weaken the electric motor. Cuccaro explained that he had never seen the approved maintenance schedule—evidence which he sub-

IT'S ABOUT TIME



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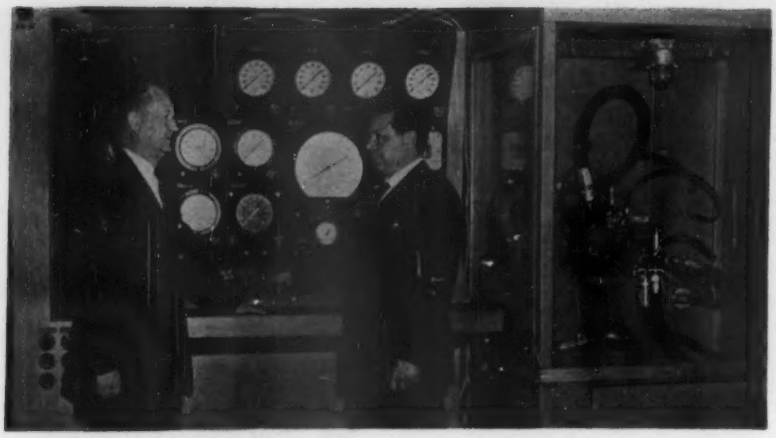

Greer Develops Jet Test Stand

Actual flight conditions are simulated on this turbojet engine tester designed by Greer Hydraulics and used by Scandinavian Airlines System on Rolls-Royce Avon engines which power SAS Caravelle jet transports. At test panel are John S. Anderson (left) SAS vice president, with Greer President Edward M. Greer. Unit is one of four on order.

sequently sought to withdraw. The work sheets to which he was working were worded in respect of a number of items in a manner which differed materially from the schedule, as, for example, in the case of the feathering check. Thus in certifying that a Check I had been carried out in accordance with the approved maintenance schedule he was in fact certifying nothing of the sort. Although he did not realize it, he was in fact certifying that the check had been carried out in accordance with the interpretation of the schedule contained in the work sheets. I do not propose to criticize him for conducting a full feathering check on this occasion, but the criticism I have made remains as an indication of the general inefficiency of the maintenance organization.

The work on the airframe carried out to comply with the Check I does not involve any point of importance. It was certified by Hardy, the company's principal licensed engineer at Blackbushe.

The work on the radio installations was carried out by an unlicensed fitter called Allen. Atkins, the licensed radio engineer who had only been with the company three weeks and barely knew Allen, was so tired after working on other aircraft during the night that he neither saw nor inspected the work. Nevertheless, since it had to be signed for, he initialled the work sheets as if he had inspected it and certified it as properly carried out. He frankly admitted that this was entirely wrong. Although he was not aware of it, his certificate that the work had been carried out in accordance with the approved maintenance schedule was meaningless, since in fact no such schedule had been approved for radio equipment installed in this aircraft a year before. It emerged that he and Allen were working 60 hr. a week each and were in fact working alternately on the aircraft that came in, there being no opportunity for proper supervision.

To summarize the evidence on the maintenance at Blackbushe—while the snags notified by Capt. Kozubski were dealt with, it is difficult to suppose that the normal work of a Check I was properly carried out. Indeed the events which followed point strongly to the fact that the source of the oil leak was not in fact discovered. It is apparent that the maintenance staff was working difficult hours and, if the admission of Atkins is a fair guide, proper supervision was largely impossible. The fact that Cuccaro, who I thought to be a conscientious man, was obliged to leave the Check I to his fitters and had not seen the schedule to which he was certifying its completion, and the absence of any approved maintenance schedule for the radio equipment do not tend to instill confidence. In short, the work of maintenance was, I think, carried out by tired men working under pressure and without proper supervision or instruction.

At 1410 hr. on Monday, Sept. 1, Juliett Echo left Blackbushe for London Airport with nine employes of the company on board and a load of stands, blocks and tackles designed for fitting the Proteus engines. The aircraft was flown by a Mr. Hatton with Capt. Mayger sitting in the second pilot's seat in order to check Hatton's competence. The passengers comprised Altena, who was due to act as second pilot on the planned flight from London Airport to Nice and thence to Lod; Boivin, an unlicensed engineer who was to act as engineer on that flight; Howard and Roberts, two other engineers (also not licensed for this aircraft) to help in loading the engines; and three cleaners who were also to assist in this work.

Hatton had previously been employed by British European Airways but had not flown a Viking for about four years, although his total flying hours were 6,550. His competence as a pilot was to be tested on this short flight by Capt. Mayger, who was one of the company's check pilots. The flight would normally have taken 10 min., but for various reasons Juliett Echo was delayed in taking off and subsequently held at the Woodley Beacon, so that the flight in fact took half an hour. Shortly after takeoff Capt. Mayger throttled back the starboard engine in order to simulate a failure of this engine and Hatton, having corrected the asymmetric swing, proceeded to climb on the port engine. His evidence, which I accept, was that the aircraft, which was very lightly loaded, was able to climb on the port engine alone at 600-700 fpm. Having heard his evidence and that of a number of experts, and having referred to the performance tests of this aircraft when it was granted its Certificate of Airworthiness in 1954, I am satisfied that its performance on one engine was above average for a Viking and that, if properly maintained and properly flown, it was capable of climbing on one engine alone even when fully laden at approximately 200 fpm. In short, Capt. Mayger's difficulties in maintaining height on the fatal flight next day should not have been due to any fault in this aircraft.

On landing at London Airport and when the aircraft had taxied to a standstill, a pool of oil was found on the tarmac underneath the front of the starboard engine, which was still dripping oil. The patch, variously estimated as representing one or two gallons of oil, was described as about the size of an ordinary school blackboard. It was also found that whereas the port tank contained 10 gal., the starboard oil tank contained only six gallons of oil, so that if Cuccaro's estimate was right it had lost or used some five gallons. Clearly the oil leak observed by Capt. Kozubski had not been corrected or conceivably another oil leak had developed.

Unsatisfactory Evidence

The evidence called as to the events which followed this discovery was remarkably unsatisfactory and I have little doubt that some of the witnesses were concerned to conceal what in fact took place.

According to Boivin and Hatton, a careful examination failed to disclose any drops of oil on the tarmac along the course followed by the aircraft and none had been sprayed on the fuselage, the latter point being confirmed by the cleaners. On the other hand, a representative of Shell-Mex who was employed to fill the oil tanks swore that the underside of the starboard main plane was covered with oil and that there was also oil over its leading edge. I am satisfied that when Juliett Echo took off from Blackbushe there were at least 11 gal. of oil in each tank and that when filled up at London Airport the starboard tank held only six. In the face of the certain loss through leaking of four gallons and the fact that the pool of oil cannot in my opinion have contained more than one gallon I find it impossible to believe that the oil had only begun to leak at the moment when the aircraft came to rest.

It was necessary to wait for a while to let the engine cool down before cleaning it off. About this time Boivin began to feel unwell. He, Capt. Mayger and Hatton had spent a week at Entebbe in August while replacements were obtained for an aircraft which had sustained failure of two engines. They had then flown back with Capt. Mayger and Hatton on Aug. 17 to England. On that flight Capt. Mayger had been taken ill and had thereafter been in bed for some days, while Boivin had likewise succumbed to a high temperature on the 18th and had been off duty as a result.

Boivin had been detailed to fly to Nice

and Lod on this occasion but was clearly unfit to do so. He went to the offices of El Al, for whom the flight was being made, and telephoned to the company's office at Blackbushe, informing the office that Juliett Echo was held up at London Airport with an engine snag and asked that the van which was being sent over to bring back the loading party should be kept until the source of the trouble had been discovered, in case any spares were required.

This message reached Hardy, who was the engineer in charge at Blackbushe, while he was having his tea. Hardy knew that there was no licensed engineer in the party at London Airport but did not think it necessary to interrupt his meal; he sent back a message that, if help was needed, Boivin should get in touch with Fields or Hunting-Clan at London Airport.

According to Boivin, he was on his way back to the aircraft when he met Capt. Mayger and Howard, who said that the leak had been located as coming from the C.S.U. All three then proceeded to the telephone and telephoned Hardy, who was now back in the office. Capt. Mayger spoke first and described the trouble as a slight leak from the base of the C.S.U.; he then, according to Hardy, explained that Boivin was unfit and asked whether Howard could go in his place. Hardy said that his answer was that he did not know Howard very well and that, so far as he knew, Howard was not very experienced, but that if he (Capt. Mayger) was satisfied with him he could take him providing he "kept his finger on him." I do not believe this account—on any view it was not a slight leak, nor does it seem likely that Capt. Mayger would have suggested that Howard should go—he had not flown with him before and, indeed, Howard had only been with the company for two to three weeks; also Howard was not licensed for the engines of this aircraft.

Trouble Diagnosed

According to Hardy, he then spoke to Howard, who, when told that it was time the trouble was diagnosed, said that it was the seal on the C.S.U. and asked for a new seal. Hardy said in evidence that he imagined that Howard must have meant the gasket, because he knew that neither he nor Boivin would be justified in taking the C.S.U. to pieces: at the same time he stated that he had no spare C.S.U. in the stores and so informed Howard, but promised to send a spare gasket. Any competent engineer would hardly use the word seal where he meant gasket or vice versa, while the suggestion of a new C.S.U. being required seems extraordinary if the gasket was the cause of the trouble. Pressed as to his conversation, Hardy proceeded to say that Howard had used both the words seal and gasket and had said that Fields could not supply him—presumably with a new C.S.U. He also stated that he had asked Howard whether it was a gasket for the base of the C.S.U. that he wanted, to which Howard assented.

Hardy, of course, knew perfectly well that if a C.S.U. were taken apart and the seal exposed it could not be refitted until it had been rig-tested and that none of the men at London Airport was qualified to carry out this work or to certify its proper completion. His evidence was in my judgment completely unsatisfactory and the truth is, as I

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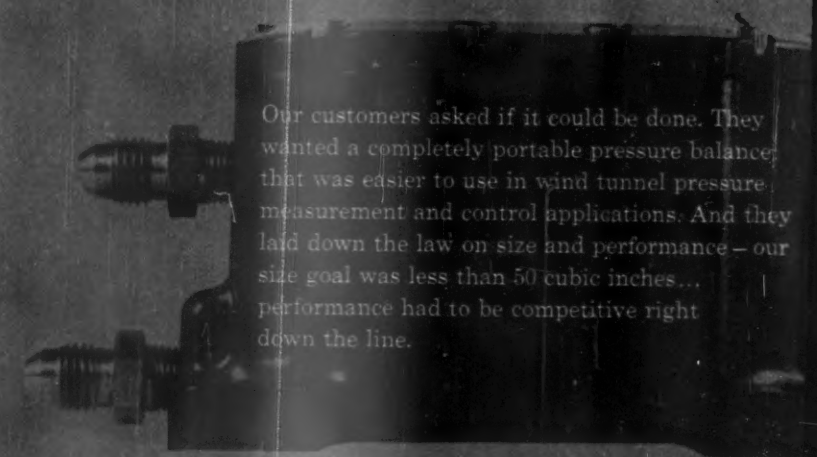

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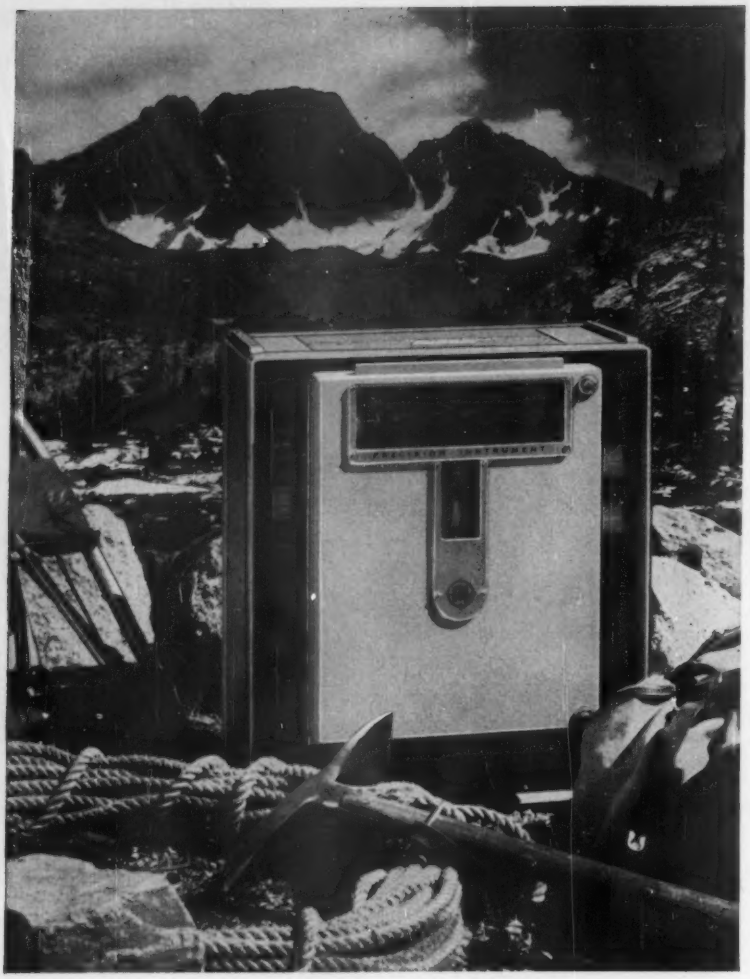

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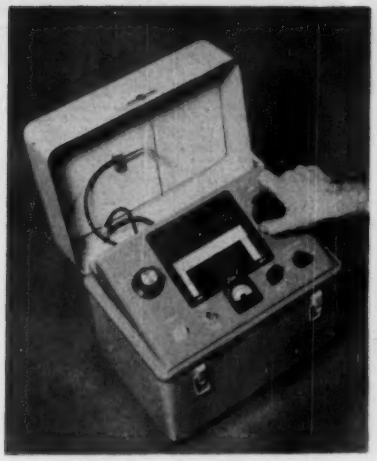
believe, that he knew perfectly well that it was the seal which was suspected and that a new C.S.U. was required if the job was to be done without breach of the regulations. The only action which he took was to obtain some spare gaskets which he handed to a Dutch first officer who was about to pass through London Airport on his way back to Holland. These spare gaskets were at one time supposed to be in a box of provisions delivered to the Berkeley Arms Hotel where Capt. Mayger and Altena were spending the night after deciding that it was impossible to effect the repair that evening. They were not found when the box was searched about 0100 hr. the next morning, although the search involved rousing both Capt. Mayger and Altena. However, they were discovered in an envelope in the wreckage of the aircraft, although how they got there no-one was able to tell me.

Unit Removed

Following the telephone conversation with Hardy, Howard appears to have gone to Farnborough to collect his kit while the engine was cleaned off with petrol. Boivin told me that when this had been done he could see that the leak was coming from the seal of the C.S.U. and that accordingly he and Roberts proceeded to remove the C.S.U. and to open it, disclosing—so he asserted—that the seal was malaligned. The Proteus engines were then loaded and lashed down, after which, the time now being about 2000 hr., Capt. Mayger and Altena left the airport. Boivin, despite his state of health, with the aid of Roberts and Howard—who had returned with his kit—then proceeded to try to rectify the trouble.

Boivin told me, and I accept, that the gasket which was taken off when they removed the C.S.U. was in perfectly good order. He also stated that examination of the seal of the C.S.U. itself with a magnifying glass showed that it had suffered no injury and accordingly they proceeded to refit the old seal and to reaffix the C.S.U. to the old gasket. This and other work designed to discover any other source of leakage occupied them until about midnight. I do not believe that the seal can have been malaligned, since, if so, it would inevitably have been damaged by being crushed against the edges of the slot and between the faces of the upper and lower parts of the C.S.U. It is, however, right to say that their work carried out on the tarmac with the aid of lamps must have been performed with considerable skill, since tests carried out after the crash showed conclusively that the seal was properly fitted and functioning perfectly, while the same was true of the gasket. The accident cannot have been caused by any leakage from the C.S.U. Boivin stated that he did not realize that the company's own schedule forbade the changing of the seal, an assertion that I have no hesitation in rejecting.

Meanwhile, Howard was by no means happy at the work which Boivin was performing. I have little doubt that he knew that Boivin was acting in breach of the regulations. About 2000 hr. Mr. Wren, one of the Ministry's marshallers at the airport, took Howard to his office to enable him to telephone to the company and heard him complain of the time they had been waiting for the spare part—in the course of this con-



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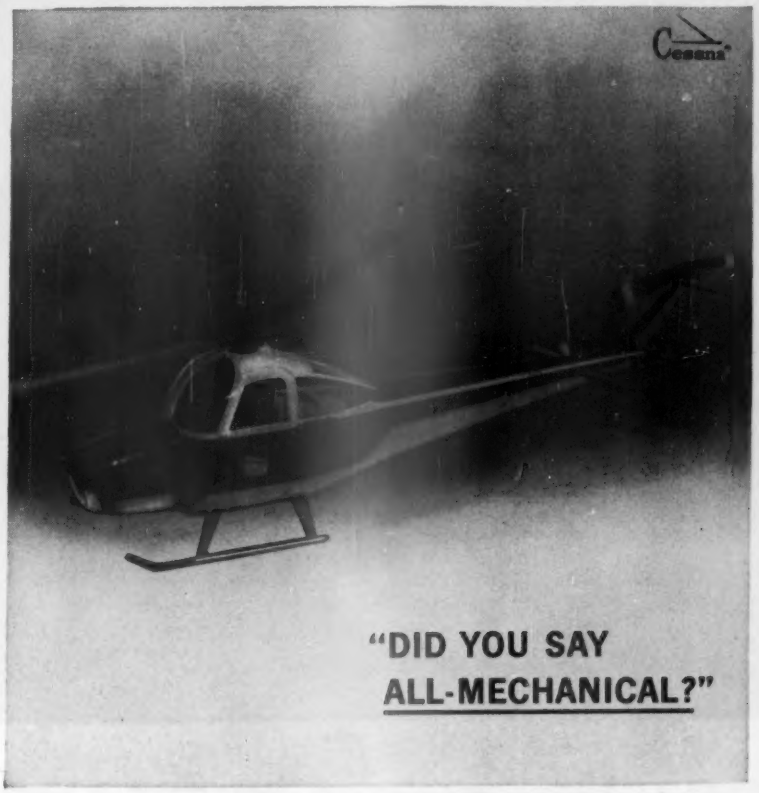
versation Howard said: "Well, if the spare part is not available, as far as I am concerned the aircraft is grounded and I refuse to sign." Shortly before this, another marshaller, Mr. Golding, spoke to Boivin, who, he said, referred to the fact that they were waiting for a spare part from Blackbushe and mentioned the C.S.U. Golding also swore that Howard actually said they were still waiting for the C.S.U. and appeared very flustered when he spoke on the telephone. Hardy denied that he had ever heard of this conversation, stating that he was available at the airport at Blackbushe until 2200 hr.; he thought it possible that the call might have been taken by an Indian navigating officer. Boivin's evidence was equally unsatisfactory: he agreed that he himself was in charge of the job as the senior of the unlicensed engineers present and that Howard had made a number of telephone calls but professed not to have known that Howard was in the least worried or to have heard of any threat not to allow the aircraft to leave if the spare was not available.

Engine Tested

Following these events there is no doubt that Boivin obtained permission from Golding to conduct an engine run and that three engine runs were made by Boivin, Howard and Roberts, in the course of which, according to Boivin, the starboard engine was completely feathered once. They finished at some time after 0100 hr., when Howard made his way to the Berkeley Arms Hotel where he had to share a room with Altena, who was thus woken up yet again.

To sum up: it seems doubtful whether the maintenance work carried out at Blackbushe discovered the source of the leak reported by Capt. Kozubski. In the face of the pool of oil discovered at London Airport and the proved loss of oil during the short flight from Blackbushe, it is difficult to suppose that that work had been properly carried out. At London Airport it seems clear that the leak was attributed to the seal of the C.S.U. — probably wrongly, for the reasons I have given. I have no doubt that Hardy was told on the telephone from London Airport that a new C.S.U. was required and that much of his evidence, as also that of Boivin, was untrue, partly because, no C.S.U. being available, Boivin proceeded to do a job (in taking the C.S.U. apart and refitting the seal) which he knew he ought not to do and because Hardy either knew or suspected that he was doing so.

Perhaps the strongest indictment of the company's methods arises from the haphazard manner in which the spare gaskets were sent to London Airport and from the fact that, although Hardy knew that there was no licensed engineer in the party, he took no steps to provide one. Even worse perhaps, Mr. Norman Ebbutt, the technical director (who was actually abroad at the time) agreed that there was no form of instruction to the company's employes as to what action to take in such circumstances, while, although the hold-up was reported by Hardy shortly after 1600 hr. to the company's headquarters at Hurn, those in charge there made no inquiry whatever as to the result or attempted to provide any assistance. Mr. Ebbutt's attitude was that the whole matter was the responsibility of the captain. It was for him to decide whether a licensed



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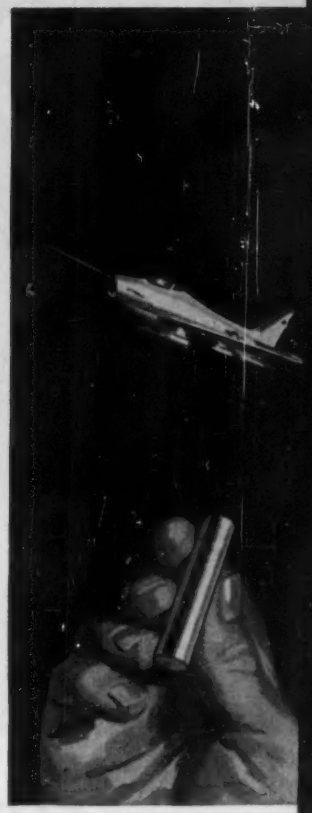

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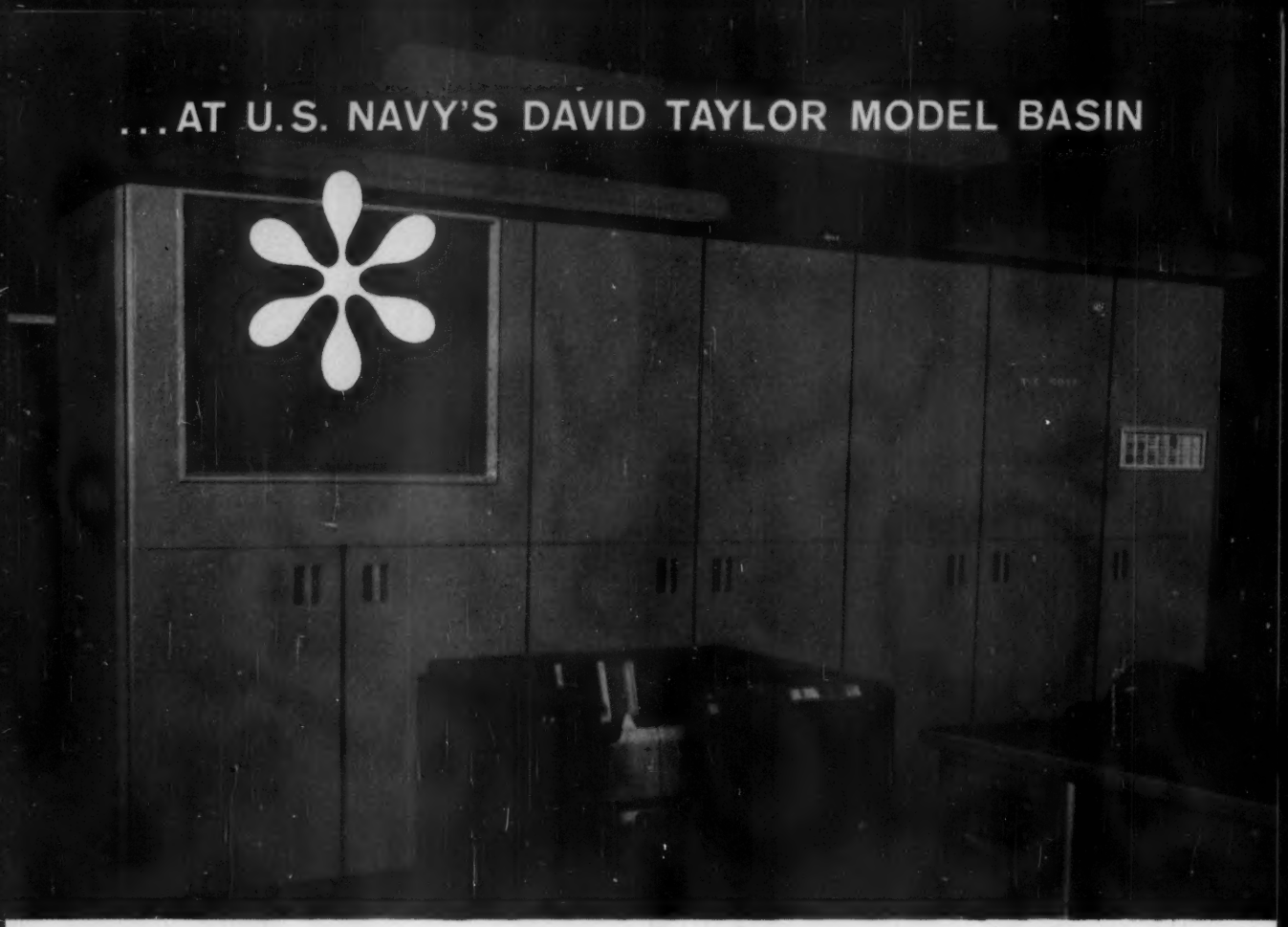

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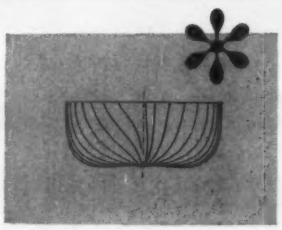

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Soviets Claim Mi-6 Helicopter Speed Record

World's record of 166.5 mph. over a 100-km. triangular closed course was set by this Mi-6 twin jet helicopter (AW Nov. 30, p. 26) carrying a four-man crew, according to Soviet officials. Previous record of 141.5 mph. was set by a piston-powered Sikorsky H-34.

engineer should be called for or not and that, so far as the certification of any work was concerned, the aircraft had left its base and was accordingly en route, so that repairs could be treated as carried out in emergency and certified by a licensed engineer on return to base a few days later after talking to the men who had carried them out, these men admittedly not being qualified to do so.

On a broad view of the evidence it is quite clear to me that the policy of this company was to keep its aircraft flying at all costs and without any real regard for the requirements of maintenance, and once an aircraft was away from its base to leave its crew fend for themselves. If any record of the work done at London Airport was ever made out—and I do not for a moment suppose that it was—it must have been destroyed in the crash.

In the course of the flight from Blackbushe to London Airport Juliett Echo was carrying a light load, consisting of the engine stands, blocks and lashings. The weight of these was shown on the load sheet countersigned by Capt. Mayger, together with the weight of some seats for the loading crew, at a total of 452 kg. (994 lb.)

The load sheet signed by Capt. Mayger before leaving London Airport purported to show that the weight at takeoff was 32 kg. within the permitted maximum. In fact, I am satisfied that the aircraft was overloaded to the amount of nearly 400 kg. (880 lb.). A great deal of evidence was adduced on this subject but it is not, I think, necessary to detail it. Briefly, what was done was to take on 144 gal. of petrol at London Airport, thus providing at least 510 gal. and probably more at takeoff, and to omit altogether the weight of the engine stands, blocks, etc. I have no doubt that this was done quite deliberately and with Capt. Mayger's full knowledge—the reason being, of course, that the weight of the engines themselves was considerable (they are put at 3,270 kg.—7,194 lb.—on the load sheet) and that if the weight of the stands etc. was also shown it would have been quite impossible to make Nice as the first stop without disclosing an overload. In other words, if the load was correctly stated, it would have been necessary to land at Lyons, thus incurring additional cost and increased time. This is, of course, easy to understand if the company was being run in such a way as to cut expenses to the minimum.

At the same time it is not to be supposed that the overload can have been a serious factor in causing the crash. This aircraft, if properly handled, ought still to have been able to climb on one engine, and the only significance to be attributed to the overload is that it certainly cannot have reduced Capt. Mayger's anxiety and difficulties in the final crisis.

As stated above, the crew consisted of Capt. Mayger, Altena and Howard. Before considering their conduct on the final flight it is necessary to consider their flying history, fitness and training.

Capt. Mayger was a pilot of great experience. He had flown some 13,000 hr. with BOAC and the R.A.F. Following dismissal by BOAC he had worked for Dan-Air for five months and then entered the employment of the company in May, 1956. He was tested by Capt. Lloyd, the chief pilot of the company, on Apr. 13 and again on Aug. 29, 1958. From May to August, 1958 he flew 389 hr. for the company, of which 135 were in a Viking. On Aug. 17, on a flight from North Africa with Hatton and Boivin, he had felt dizzy and Hatton had had to take over the aircraft, a Douglas DC-4. Capt. Mayger had described his symptoms as malarial and had said that he had been unable to recognize the other members of the crew. On reaching Hurn he had gone home to bed, where he had run a high temperature due to an infection diagnosed by his doctor as streptococcal, and had not been pronounced fit until Aug. 26.

On Saturday, Aug. 30, he flew with Altena in Juliett Echo, leaving London Airport at 1325 hr. and landing at Blackbushe after a flight of 10 min. At 1635 hr. he left Blackbushe with a different crew and flew to Paris, Nice and back to Blackbushe, arriving at 0230 hr. on Aug. 31. After spending the remainder of the night with friends near Blackbushe he took off at 1000 hr. on the morning of Sunday, Aug. 31 in a DC-4 and flew to Barcelona, returning to Blackbushe at 1925 hr. that evening, when he travelled to The Wheatsheaf, near Basingstroke, to spend the night with his wife and child. Mrs. Mayger stated that he had 7½ hr. sleep that night.

On Sept. 1 he reported for duty at Blackbushe and flew to London Airport, testing Hatton on the way, and thereafter remaining on the airport until at least 2000 hr. and possibly later, when he went to the Berkeley Arms Hotel for the night. According to the evidence put before me, he had no food that evening and only a small whiskey and soda before going to bed. He was aroused about 0100 hr. in the course

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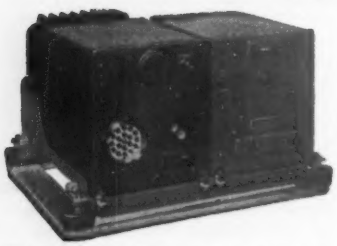

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of the search for the spares, when he was found asleep in bed with the light on and a small wireless playing, and told the proprietor to look for himself or to ask Altena to look. The search which followed must have woken him thoroughly. The manager was unable to find the spares and called Altena, who likewise could not find them and spoke out of the window to the company's driver to tell him so. Capt. Mayger was called at 0315 hr. with coffee and a continental breakfast, but ate nothing and was late down. A post mortem following the crash showed that his stomach was entirely empty, and there is no doubt that he can have had nothing to eat since at any rate leaving Blackbushe on the previous afternoon.

Pilot's Ability

It is necessary to consider whether his ability to fly the aircraft on the morning of Tuesday, Sept. 2, was in any way limited by lack of training in flying on one engine or by fatigue.

As to training: there is no doubt that any pilot, however experienced, needs a six-monthly check in the various drills required in emergency. Such a check is required by Article 18(4) of the Air Navigation Order 1954 and by Regulation 44 of the Air Navigation (General) Regulations 1954. It is normally called the six-monthly check, since a pilot must have undergone this test within the period of six months before flying a public transport aircraft, or twice within the 12 months before any such flight, the checks being administered at intervals of not less than four or more than eight months.

I have stated in a previous report, and the point has since been emphasized by Mr. E. Faye, Q. C., in his report on the accident sustained by Aquila Airways, that a pilot cannot be properly tested except on a special flight undertaken for the purpose. In the case of a twin engined aircraft the check should involve a true stoppage of one engine and a landing performed solely with the aid of the other, at least one such landing being carried out by night at any rate on alternate checks.

It was established in evidence that prior to 1958 the six-monthly checks which ought to have been administered to Capt. Mayger were not in fact administered with the proper frequency or at the proper intervals. It was, however, said on behalf of the company that proper checks were applied by Capt. Lloyd on Apr. 13 and again on Aug. 29, 1958. I turn to consider each of these tests.

The first of these checks was said to have been carried out on Apr. 13, 1958 in the course of a positioning flight from Southend (where freight brought from Hamburg had been delivered) back to the company's main base at Hurn. The aircraft used was Juliett Echo and the flight is recorded in the journey log book, from which it appears that the aircraft took off at 1400 hr. in the afternoon and landed at 1435. The certificate was signed by Capt. Lloyd with the comment "Nothing to worry about."

Capt. Lloyd told me that in the course of the flight he simulated a failure of the port engine—he did not suggest that the actual landing was carried out on the starboard engine only. He agreed that it was untrue that the aircraft was loaded to the maximum permissible landing weight, although he had so certified. The aircraft was in fact empty, save for the crew of four and perhaps some ballast. Turning to the details of the check, it will be seen that the form contains in the left hand margin a series of crosses against those items required in a check on a first officer and another series for the test on a captain. Capt. Lloyd agreed that he had failed to complete the form properly in the case of the item "simulated engine failure," since he had failed to show which engine was cut out. Likewise, in the case of "landing with one engine inoperative" he had so completed the form as to suggest that this was done by night, whereas in fact it was in the early afternoon and the other engine was not in fact inoperative. It was also incorrect that any overshoot had been carried out. Capt. Lloyd said that an overshoot had been simulated as they were flying along, as he found that doing it in this way saved time. Capt. Lloyd himself agreed that the completion of the form was lax. Having listened to his evidence, I have the gravest doubt as to whether Capt. Mayger was subjected to any serious test on this occasion and I am entirely satisfied that the test as administered provided no sufficient check on his ability to fly and land the aircraft with one engine inoperative.

Improper Checkout

Very similar criticisms apply to the second check of Aug. 29 and the certificate. On this occasion the aircraft—a DC-4 (a four-engined aircraft)—was being flown from Hurn to Blackbushe on a positioning flight. I invited Capt. Lloyd to produce any document to confirm that the aircraft was carrying a maximum load, but he failed to do so, and I have little doubt that it was not. On this occasion the aircraft took off at 2100 hr. and landed at 2125 hr., so that the check was in fact carried out at night, but reference to the details as completed shows that some items are said to have been done by day and others by night. Here again there was no suggestion that a true landing with one engine inoperative as opposed to a simulated landing was carried out and I have little doubt that the whole test was perfunctory and of little value.

It is perhaps permissible to compare the test carried out by Capt. Mayger on Hatton on Sept. 1 during the flight from Blackbushe to London Airport and the certificate. It will be remembered that Hatton had just joined the company, not having flown a Viking for over four years, and that his competence to do so was to be established in order to comply with Regulation 44 cited above.

Capt. Bright, the chief pilot, told me that he was responsible for detailing Capt. Mayger to carry out the check in the course of this flight. Of course, Capt. Bright knew that this was a positioning flight with a view to loading the engines at London Airport and that the aircraft was admittedly very lightly loaded. Capt. Bright gave evidence in the course of the Inquiry I conducted in 1957 into the crash at Blackbushe of a Viking aircraft of Eagle Airways, G-AJBO. On that occasion I found myself unable to accept his evidence as to the proper conduct of a six-monthly check, it being clearly established that the check he had certified as carried out by night was in fact carried out by day. In ordering the check on Hatton on this occasion Capt. Bright must have known, as also must Capt. Mayger, that a certificate to the effect that the aircraft was loaded to the maximum permissible landing weight would be untrue.

It is well known that single engine practice landings are not permitted at London Airport, so that the details as completed are obviously misleading. Having listened to Hatton's account of the manner in which this test was carried out with a simulated engine failure and a landing on both engines and to the evidence of Mr. Chouffot, one of the Ministry's inspectors, I have no hesitation in finding that the test as administered was quite insfficient to comply with the regulation and to establish Hatton's competence to fly this aircraft.

It is fair to Capt. Bright to say that he had repeatedly pressed for proper facilities to check pilots. He had urged to be allowed to arrange special flights for the purpose and his representations had been put forward by Capt. Lloyd to Capt. Kozubski. The latter had refused to agree, and Capt. Lloyd admitted that the company was in fact run to the orders of Capt. Kozubski; Capt. Bright said that Capt. Kozubski was "the driving force"—adding "most business men are." The short fact is that this company was being run in a manner designed to keep expense to the minimum and that proper checking and training facilities were deliberately refused with this object in view. On this aspect of the case I must also refer to the position of Altena. He had had less than 1,000 hr. flying, of which only about 24 hr. had been in twin-engined aircraft. His employment with the company as a probationary pilot dated from Saturday, Aug. 30; it was suggested by Capt. Lloyd and Capt. Bright that his competence was tested by Capt. Mayger on that date in the course of the positioning flight of Juliett Echo from London Airport to Blackbushe. On that occasion the actual flight lasted 10 min., the aircraft landing at Blackbushe at 1335 hr. It is to be observed that whereas Capt. Mayger entered a note in the journey log book on Sept. 1 to the effect that he had carried out a six-monthly check on Hatton, no such entry was made in regard to Altena after the flight of the Aug. 30.

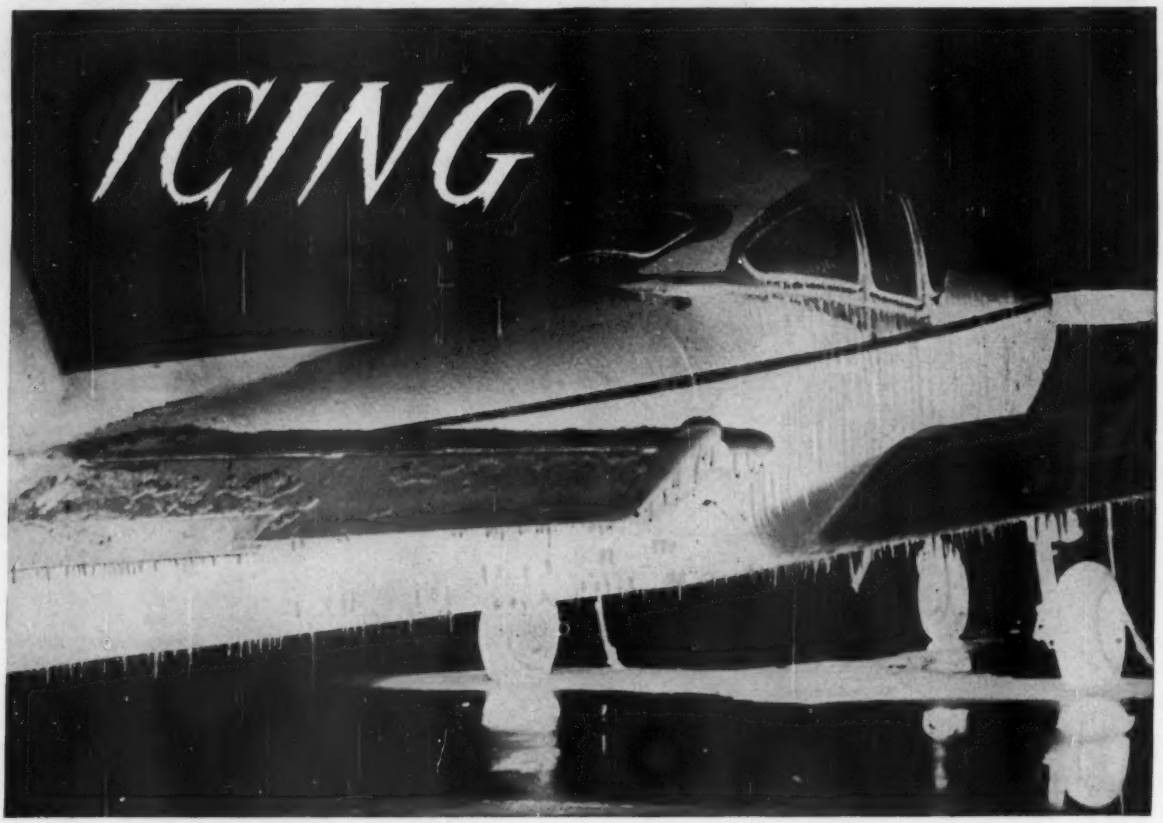
Ability Approved

Capt. Lloyd stated that after his arrival at Blackbushe he had questioned Capt. Mayger as to Altena's competence and that Capt. Mayger had told him that he was fully satisfied with the check and thought Altena would be a good type to employ and would be O.K. to go to Tel Aviv the next week. Capt. Bright stated that he had spoken to Capt. Mayger on the Monday, although he could not remember at what time, and that Capt. Mayger had confirmed that he had tested Altena's competence and found him satisfactory. He had then, when giving orders for the check on Hatton, given Capt. Mayger two forms, one to be completed for Altena and the other for Hatton and had agreed that Altena should act as first officer on the flight from London Airport.

I do not believe that Capt. Mayger had

FLY WEATHER-WISE

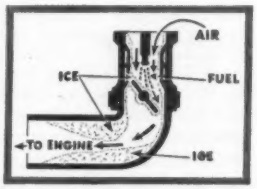
These weather items prepared in consultation with the United States Weather Bureau



Some observations on a major weather problem in aviation

Layer-type clouds—Icing conditions may extend over broad areas in this cloud formation causing continuous ice build-up within the cloud layer.

Cumuliform and cumulus clouds—As contrasted to layer-type clouds, icing in cumuliform clouds may be found at considerably higher altitudes. In the tops of cumulus clouds, even with temperatures above freezing, clear ice may be formed at a dangerously rapid rate. This is especially true in such clouds formed over or near large bodies of water.



Temperature—Heaviest icing usually occurs in 15°F. to 32°F. range. Therefore, watch should be kept for ice formation on aircraft when flying in clouds or precipitation if outside air temperature is in or near this range. Remember, even in clear weather carburetor icing may occur when temperatures are between 20°F. and 70°F. and humidity is high. Temperature of air passing through carburetor may drop as much as 60°F., causing frost to form and restricting flow of fuel to engine.

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been instructed to check Altena on the flight from London Airport, nor do I believe the evidence of Capt. Lloyd or Capt. Bright that he said he had done so and found him satisfactory. The absence of any note in the log book in contrast to that made in the case of Hatton is significant. It is also curious, if their evidence were true, that the form for Hatton should have been completed and handed to him at London Airport, whereas the form for Altena was found in the wreckage uncompleted. I daresay that Capt. Mayger may have said that Altena was a good type and may have agreed to take him on the flight to Nice and test him in the course of it. Whatever may or may not have been said, both Capt. Lloyd and Capt. Bright knew perfectly well that the aircraft had flown from London Airport empty and any enquiry must have shown that the flight lasted only 10 min. I am entirely satisfied that no proper test was carried out, or indeed could have been carried out, in the course of this short flight. It was admitted that the company was very short of flying personnel, and here also I have no doubt whatever that the requirements of the regulations were being disregarded in the interests of the commercial advantage of the company.

I have already dealt with the position of Howard, an airframe engineer, sent on this flight after less than three weeks employment by the company—a man who was not licensed to certify any work to the engines of this aircraft and in regard to whom Hardy advised Capt. Mayger to "keep his finger on him."

Insufficient Checks

To sum up: I am satisfied that the checks carried out on Capt. Mayger in April and August 1958 were insufficient to test his ability to deal with a true emergency involving the flying and landing of this aircraft on one engine. I am equally satisfied that no proper test as to the competence of Altena to act as first officer of this aircraft had been carried out before he took part in the fatal flight on the morning of Sept. 2 and that there is no reason to suppose that Howard's experience fitted him to form a member of this crew upon whom the pilot could rely.

There can be no doubt that both Capt. Bright and Capt. Lloyd were fully aware of the fact that no proper check had been carried out to test Altena's efficiency. It is, I think, a grave criticism of Capt. Bright that he should have allowed Altena to go as first officer, bearing in mind the criticism to which he had been subjected in my previous report.

The question of fatigue is important. Capt. Mayger had been ill from the 17th until Aug. 26, when he was pronounced fit for duty. His doctor, who gave evidence, stated that there was no reason to suppose that this illness should have affected him following his return to duty, even though his infection had resulted in a high temperature for a few days.

It is clear, however, that following his return to duty and prior to the final flight he had not been allowed the rest times required by Article 34F of the Air Navigation (Fifth Amendment) Order, 1957. Under the regulation no pilot is to be required to make a flight in a public transport aircraft unless he has had at least 10

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hr. rest since his preceding duty period.

On Aug. 30 and 31 he made a series of flights. Under the Air Navigation (Fifth Amendment) Order 1957, and under the provisions of the company's operations manual designed to give effect to the order, a crew is to be regarded as on duty 45 min. before scheduled time of takeoff and for 30 min. after landing. In the result he was on duty as follows:

From 1225 hr. on Saturday, Aug. 30, until 0200 hr. on Sunday, Aug. 31. He accordingly became entitled to 14 hr. rest from 0200 hr. that morning. In fact, in breach of Article 34F of the order, he got 7 hr. 15 min. before he again went on duty. Under the order, if the period between two duty periods is less than 10 hr., the two duty periods are to be treated as one duty period.

On Sunday, Aug. 31, he was on duty from 0915 hr. until 1955 hr., and since this duty period was to be treated as one with that of Saturday, he had been on duty for 31 hr. 30 min., a gross breach of Article 34E of the order, since the maximum permissible flying duty period for a two-pilot crew is 16 hr.

However, he was again on duty on the morning of Monday, Sept. 1, at any rate from 1325 hr., and owing to the trouble found at London Airport was evidently in the airport and consequently on duty until at least 2000 hr. He cannot have had 10 hr. rest from the time he left the airport until he got back here, which on the evidence was at about 0400 hr. BST on the morning of Tuesday, Sept. 2nd. In the meanwhile he had gone to bed without a meal and after drinking only a small whisky. I have already described the circumstances in which he was disturbed at 0100 hr. and the fact that he did not eat his breakfast and, as it would appear, dozed off again, since he was late down and had to be roused by Altena and Howard as the taxi was waiting.

On the above bare statement of the facts it would indeed be strange if Capt. Mayger was not suffering from fatigue to a serious degree.

Two Hours Sleep

Altena had also had a disturbed night, since he had been roused first about 0100 hr. to look for the spares and again soon afterwards when Howard came to bed, as they were sharing a room. Howard himself cannot have had more than about two hours sleep.

In short, this crew had not had the rest desirable, and to which indeed they were entitled under the regulations, before taking off in an aircraft whose condition was suspect, overloaded in order to enable it to make a flight which was beyond its proper range with the load it carried.

The gravity of this matter, and of the disregard of the regulations in the case of the rest time to which Capt. Mayger was entitled, became apparent when it was disclosed that the company had been prosecuted and convicted in May, 1958, on 10 charges involving breaches of the regulations governing flight time limitations, and that these convictions involved both excess hours and insufficient rest accorded to pilots.

That this prosecution had not affected the company's policy to any serious extent is clear, since on Aug. 26, 1958, following an investigation by the Ministry, Mr. Branson from Headquarters and Mr. Stokes from the Southern Division of the Ministry interviewed Capt. Lloyd, Capt. Bright and Group Capt. McDonald of the company's London office and pointed out that the spot check which they had carried out disclosed three breaches of Article 34(E) involving excess hours and three involving insufficient rest. When the facts in regard to Capt. Mayger's insufficient rest are considered in the light of this interview only four or five days before, it is obvious that the regulations were being deliberately disregarded. Capt. Lloyd explained that he had spoken to Capt. Kozubski about breaches of the flight time regulations before the interview with the Ministry's officers on the 26th but that Capt. Kozubski took the view that a breach was not a breach provided it was reported afterwards.

Flagrant Breach

I understood this to mean that the company would report the breaches with an explanation of why they had occurred and thus expect to receive a dispensation from the Ministry. No doubt this course might excuse an occasional and unintentional breach, but it cannot serve as any explanation of a series of flagrant breaches, more especially as, so far as I am aware, none of them had in fact been reported and indeed, as I am satisfied, the company had not the slightest intention of doing so. I understood from the Ministry's officers that these matters were the subject of consideration with a view to prosecution when the crash occurred. I imagine that thereafter action was deferred pending the inquest.

I turn to consider the circumstances of the final flight in the light of my findings.

The state of mind of the crew is to be assessed in the light of Mr. Searle's description of the aircraft at the threshold of the runway with Howard out on the tarmac obviously trying to observe whether there was any sign of an oil leak.

At 0609 hr., after leaving Dunsfold, Capt. Mayger announced that he had engine trouble, confirming his height at 7,000 ft. and his ability to maintain altitude. It is, of course, possible that his engine trouble bore no reference to an oil leak. This seems improbable. It is also possible that he had no oil leak but that some instrument failure caused him to think so—there is no reason to think this likely. It is possible that there was an oil leak, and the fact that Mr. Newton of the Investigation Branch found signs of oil sprayed from the starboard engine on the starboard tail plane when investigating the wreckage, is an indication that there was a true leak. It is also possible, as was suggested to me, that the engine was gulping.

Gulping occurs as follows: this engine has a scavenge pump which draws oil from the sump via a filter and then passes it back to the tank for return through the engine. At one time it was common for the rather fine mesh of the filter to become blocked with carbon, in which case the oil, unable to percolate through the filter and subjected to the pressure of the entry of further oil, would be thrown up through the breathing exits of the engine. Alternatively this might occur if water got into the oil in quantity and collected in the sump. The probability

of gulping rests on the fact that it was at one time comparatively common in Hercules engines made prior to 1954 and normally occurred about 15 min. after takeoff while climbing and in cases where an engine had run about 900 hr. since its last overhaul.

It is, of course, possible that this was the cause of the engine trouble, but I think improbable. In the first place it is likely, although not certain, that the engine had been fitted with a wider mesh filter so as to render carbon blockage a most improbable cause. In addition, the Check I at Blackbushe showed the filters clean of carbon. Moreover, gulping can hardly be the explanation of the oil leak found at London Airport, which would seem to involve one gulp at the very end of the aircraft's taxiing. Further, if this aircraft gulped at 7,000 ft. and was thereafter merely throttled back for five minutes, I am satisfied on the evidence that all the oil in it would have been gulped away and that the engine would never have been found properly lubricated as it was after the crash.

The record of the R/T message indicates no anxiety at this stage. My conclusion is that there was probably an oil leak apparent from the cockpit but that it was not considered serious and accordingly Capt. Mayger merely throttled back instead of feathering the starboard engine.

At 0616/7/8 Capt. Mayger was told he could set course from Dunsfeld to Blackbushe beacon and descend to 3,000 ft. to arrive at the beacon at that height. Perhaps the most remarkable feature of the flight is that at this point he made his course towards Epsom instead of towards Blackbushe; the magnitude of the error was 70 deg.

Two Possibilities

There are really two possibilities which can explain the course taken—incidentally the error is difficult to credit when one reflects on the experience of the pilot, the fact that he was flying in bright sunlight and had in addition a magnetic compass if he cared to refer to it. Firstly, either he or Althena simply tuned the ADF equipment to Epsom instead of Blackbushe, or there is an elaborate scientific explanation, namely that Capt. Mayger was misled by the Amsterdam beacon. It so happens that Blackbushe beacon was established some years ago operating on a frequency of 379.5 kc. and to an effective range of 15 naut. mi., interrupting its signal at intervals of eight times per minute by the code signal MB. Meanwhile, Amsterdam, which is a powerful navigational beacon with a frequency of 381 kc., transmits its signal interrupted at half minute intervals with its code sign PHA. If a set is mistuned towards Amsterdam at a point outside the 15 mi. radius of Blackbushe, the effect may be that the radio compass needle will be influenced by the Amsterdam signal and will show a false reading. If the pilot follows this bearing he will fly an incorrect course and the error is likely to increase.

It is not necessary in this report to describe in detail the scientific problems involved or the question of whether at the particular distance, if properly tuned, the set will enjoy the proper number of decibels over one microvolt per meter to ensure against this distortion. To put the problem very briefly, the ADF panel to which the pilot has to tune his set is rather above his

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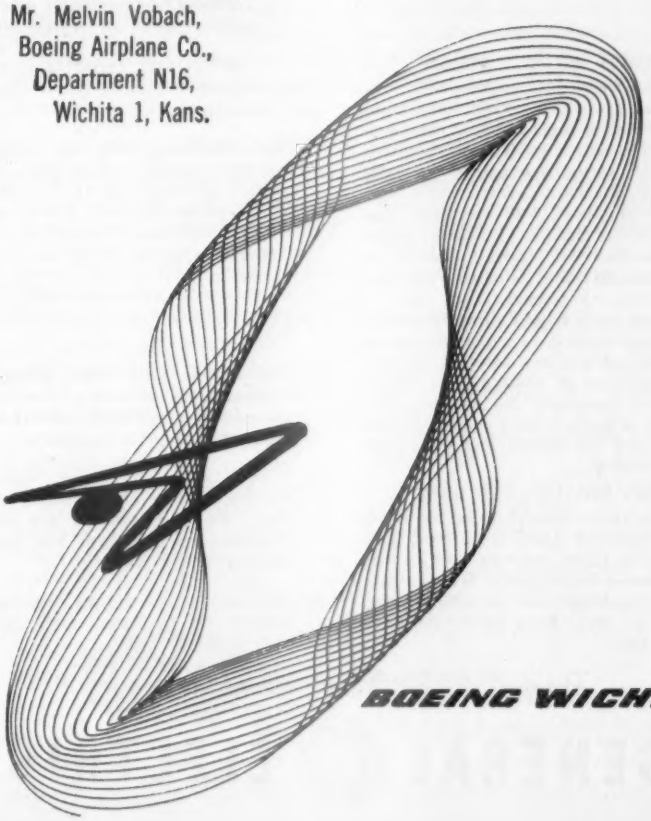

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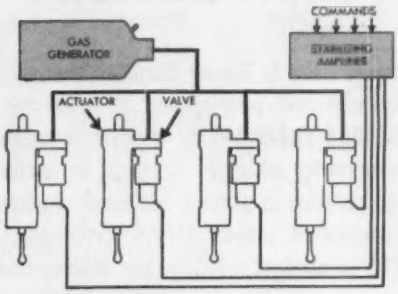

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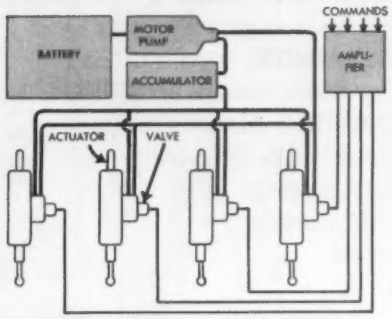

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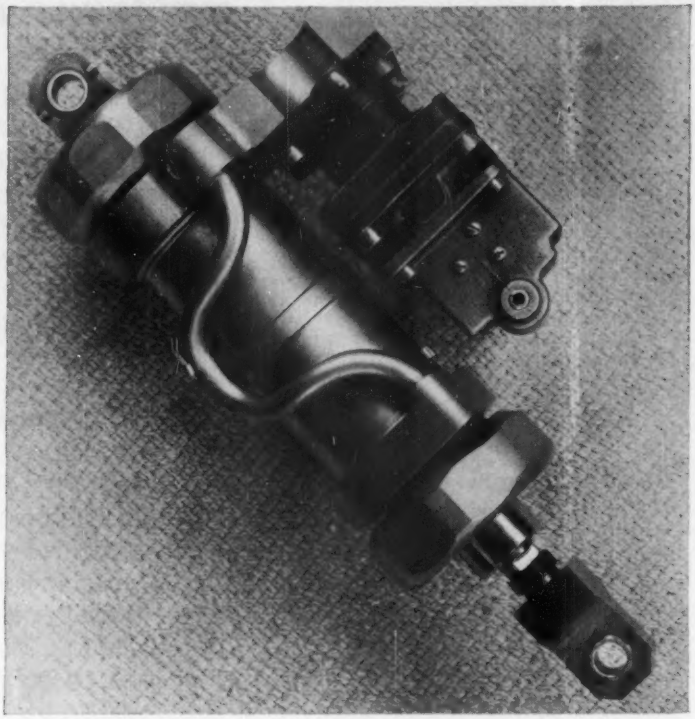

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head and is only marked at every 10 kc. It is obviously easy to mistune, and if he mistunes outside the area of 15 naut. mi., where protection is assured, he may find that his radio compass is pointing away from Blackbushe, with the result that if he follows it blindly he is flying off course.

It is not possible to determine whether in this case Capt. Mayger and his crew followed the course they did because they flew towards Epsom through forgetting to tune to Blackbushe or because they mistuned in the direction of Amsterdam and were thus led gradually astray.

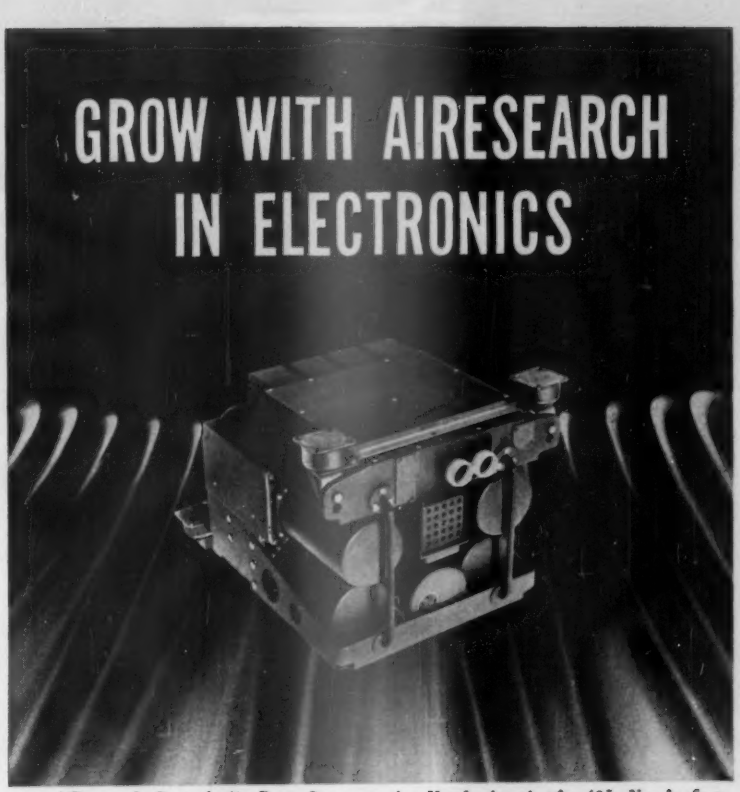
At 0622 Juliett Echo was clearly informed that she was off course, and it is clear from the chart and from what followed that the crew had no idea how far off course they were but that at this stage QDMs were sought and that the aircraft began to execute a turn to the west to correct the error. A remarkable feature of the R/T record is that the pilot does not seem to have relied at all on his magnetic compass which ought to have suggested his error long before he was warned of it. Any suggestion that the proximity of the Proteus engines might have affected this compass was disposed of in evidence.

At 0625/6 the real crisis arose when Capt. Mayger found that he could not unfeather or maintain height. He had feathered at 0616 by depressing the feathering button in the manner I have described. There can be no real doubt that either the button was held in, or more probably stuck in, with the result that by 0625—nine minutes later—the motor was burnt out. There is a warning light fitted which would normally show red if the motor was being run unduly. Obviously this cannot have been observed, possibly due to the bright sunshine in which the aircraft was flying. Alternatively, but I think less probable, the motor may have been damaged in the course of the feathering checks on the various ground tests.

I have already referred to the extraordinary feature of the pilot coming down from 3,000 ft. to 1,000 or 800 without a word of warning to anyone. No doubt he thought that he was close to Blackbushe and could afford to lose height, but it is an almost inflexible rule that, if faced with a landing on one engine, an aircraft should maintain height until certain of the landing. It is also difficult to understand how the pilot could have failed to climb on one engine, even with an overload, from 1,000 or 800 ft. The answer can, I think, only be that he had lost flying speed while trying to talk on the R/T, tune the ADF equipment situated as it is in an awkward position above his head, and fly the aircraft asymmetrically. He may too have been lulled by the thought that he could safely let his speed down since he had in reserve the power of the starboard engine.

As appears from the chart (p. 119), it was about this time that the swing to starboard began. The aircraft had lost height and speed and was virtually taking control. At 0629/30 Altena took over the R/T and thereafter the messages were his. Bearing in mind his lack of training it is to be remembered that his messages were clear and showed no sign of panic up to the end, a little over two minutes later.

To sum up: it seems likely that the oil leak showed itself at 7,000 ft. but that



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it did not seem serious; it must be largely speculation as to why this aircraft took the wrong course. Apart from the technical matters to which I have referred it was an extraordinary error for a pilot of this experience to make in the circumstances and despite the assistance of the sun and his magnetic compass. Equally extraordinary are the loss of height without warning and the failure to observe the probable red light warning of the feathering motor, and finally allowing the speed to drop so that he could no longer climb on one engine.

I can conceive of no answer to these criticisms save that Capt. Mayger was flying this aircraft in a manner which was quite out of keeping with his experience. I have little doubt that the explanation is that he was affected with fatigue to a very marked extent. He had been ill a few days before, he had had quite insufficient rest, the maintenance of his aircraft was subject to grave suspicion, his crew was scarcely known to him and inexperienced. This man was put in a situation which no pilot should be required to face, and it is dangerous to criticize in detail his handling of it.

The attitude of the company was remarkable. Those directors who gave evidence put the whole blame for this accident on the captain. It was said that the loading responsibility was his, and his the responsibility for taking off in the aircraft. He also had been responsible for testing Altena and in effect, as was suggested, had chosen his crew. They were not prepared to admit any criticism of their own actions or that the actions of this captain might have been affected by the policy of the company.

Accident Findings

In the light of my findings I now turn to answer the questions put by H. M. Attorney-General:

Q. Who was the registered owner and who was the operator of the aircraft?

A. Independent Air Travel, Ltd.

Q. Did the aircraft have a valid Certificate of Airworthiness?

A. Yes.

Q. Had the aircraft been maintained in accordance with approved maintenance schedules as regards the airframe, the engine and the radio installation?

A. (a) There is no evidence to the contrary.

(b) No. I doubt whether the maintenance carried out at Blackbushe in in the course of the morning of 1st September 1958 was properly carried out. I am satisfied that the work performed at London Airport was carried out in disregard of the terms of the approved maintenance schedules by men who were not qualified to perform it and who were not licensed to certify it.

(c) No. There was no approved maintenance scheduled although the particular equipment had been installed in the aircraft for the better part of the year.

Q. Was the aircraft properly loaded?

A. No. There was a clear and deliberate breach of Regulation 33 of the Air Navigation (General) Regulations 1954.

Q. Were the pilots properly licensed and experienced to carry out the flight?

A. (a) Capt. Mayger was properly licensed and was an extremely experienced pilot, but I am not satisfied that his six-monthly checks to confirm his ability to handle this aircraft in an emergency had been properly carried out so as to comply with the regulations.

(b) Altena was properly licensed but was not properly experienced. His competence had not been established by the company, who were accordingly in breach of Regulation 44 of the Air Navigation (General) Regulations.

Q. Were the pilots suffering from fatigue?

A. Capt. Mayger certainly was. In his case following a number of breaches of Article 34(F) of the Air Navigation (Fifth Amendment) Order, 1957, he was required to fly in breach of Article 34(B). I am not prepared to find that Altena was suffering from fatigue.

Q. Did the Air Traffic Control Services function efficiently and render all possible assistance?

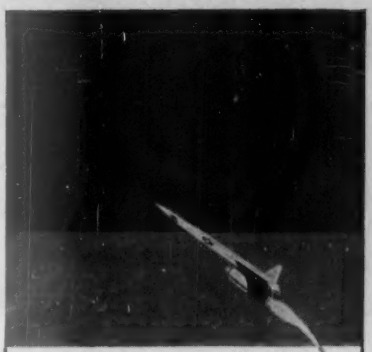
A. Yes. I have not attempted to deal in detail with the minor critcisms that were advanced. I am entirely satisfied that the Air Traffic Control officers not only did their duty but in fact did far more than they were strictly required to do and no possible criticism attaches to them.

Q. What was the cause of the accident?

A. The aircraft was allowed to lose height and flying speed with the result that the pilot was no longer able to exercise asymmetric control. While the above represents the final cause of this accident, I believe that the evidence warrants a finding that the true cause was the outcome of the chain of circumstances which I have detailed.

Q. Was the accident caused or contributed to by any act or default on the part of any person or party?

A. Yes. The pilot ought never to have taken off in this aircraft which to his knowledge was overloaded and with a crew which he must have known were not of proved competence and at a time when he himself was suffering from fatigue. He may or may not have known in addition that it had not been properly maintained. The manner in which he handled it, particularly in following the wrong course and losing height and flying speed must have contributed to the accident. The conduct of the pilot and the whole course of events which I have detailed were, in my opinion, contributed to by the deliberate policy of this company, which was to keep its aircraft in the air and gainfully employed regardless of the regulations or of the elementary requirements which should enjoin consideration for the conditions of working of its employees or the maintenance of its aircraft. I concur in the submission of counsel for the Air Registration Board that with a company so organized and with such an attitude to its responsibilities it is perhaps only surprising that an accident such as this did not occur before. In my judgment any responsibility of Capt. Mayger is to be viewed in the light of his position as an employe upon whose



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shoulders an intolerable burden was placed.

In the course of this Inquiry a number of matters were raised which were either suggested by counsel or appeared to myself and my assessors as deserving consideration with a view to recommendations. They are as follows:

(a) The conduct of a six-monthly check.
(b) Whether the limitations of Articles 34(B) and 34(E) of the Air Navigation (Fifth Amendment) Order 1957 provide proper protection both for the public and the crew of a public transport aircraft.
(c) The risks involved in tuning ADF equipment to a beacon outside its service range.
(d) Whether any provision is required with a view to ensuring the preservation of records of maintenance or rectification work on an aircraft when carried out away from its base.

I propose to deal with these matters seriatim.

Six-Month Check

In the report of Oct. 17, 1957 (C.A.P. 1946) on the accident at Blackbushe to Viking G-AJBO I made certain recommendations with regard to the conduct of a six-monthly check and in particular that it should be conducted on a special flight, that in the case of a twin-engined aircraft it should include on at least every other occasion a landing with one engine inoperative at night and finally that steps should be taken to facilitate the checking of a company's records. These recommendations were largely endorsed in the report of July 19, 1958 (C.A.P. 149) into the accident to Solent aircraft G-AKNU but have not, so far as I am aware, been implemented.

The circumstances of the present Inquiry serve to reaffirm their importance and I venture to hope that they may receive further consideration. These checks cannot be properly carried out in the course of an ordinary flight, simulation is no substitution for real stoppage of an engine, nor for a real overshoot or a true landing with one engine inoperative. A system which makes it easy for a company either to omit the checks or to carry them out in a perfunctory manner and difficult for any inspector to ascertain the position ought not to be permitted. Certainly the loss of life involved in this accident and in that at Blackbushe might never have occurred if the pilots involved had received the proper tests which a true six-monthly check would provide.

Articles 34(B) and 34(E) of the Air Navigation (Fifth Amendment) Order 1957: These articles provide a limitation on the flight time hours of the crew of public transport aircraft "for preventing excessive fatigue." A public transport aircraft is defined in Article 73 of the Air Navigation Order 1954 as "an aircraft carrying passengers or goods for hire or reward." The definition in the Amendment Order seems to require reference to the above definition in Article 73.

In the course of the hearing, a document described as Captain Mayger's personal flying log was put in. At a glance this appeared to show numerous flights in excess of the flight times stipulated by the Articles of the Fifth Amendment Order. For example, on May 16, 1958, Capt. Mayger left Hurn at 1315 hr. in Juliett Echo, flew to London Airport, thence to Rome, and on to Athens, arriving at 0005 hr. on the morning of the 17th. Forty-five minutes later he left for Lod, where he landed at 0435 hr. He had thus been on duty for 16 hr. and 35 min. if the flight had terminated at Lod and should thus have had a rest period of 18 hr.

In fact, however, he took off from Lod after one hour and 15 min. on the ground and flew to Nicosia in Cyprus, and from there to Basra, which he reached at 1220 hr. on the 17th.

I was informed by counsel for H.M. Attorney-General that the company had satisfied Mr. Branson of the MTCA that the flight from Lod to Nicosia and thence to Basra was not a public transport flight as defined by Article 73 since the aircraft was not carrying either goods or passengers and therefore the excess over the 16 hr. flight time permitted where two pilots are carried in an aircraft was only 35 min. In many other instances where the flight times were grossly in excess of those permitted for a public transport flight and the aircraft returned to this country after long flights to the Middle East and elsewhere with no proper rest at any stage, the company was able to show or Mr. Branson was compelled to accept that the aircraft on the return flight carried no goods or passengers and that the requirements of the regulations did not accordingly extend to this flight. Counsel for H.M. Attorney-General accordingly conceded that in regard to these flights it could not be said that the provisions of Articles 34(B) and (E) were breached or any offence committed provided always that the pilot had the rest time required by Article 34(F) before the next public transport flight, i.e. the next flight on which he actually carried passengers or goods for hire or reward.

It is obviously ridiculous that a pilot should be allowed to fly an aircraft with a load of passengers or freight for the maximum permissible flight time and thereafter, without rest, should be required or allowed to fly back direct to this country or to some other destination simply because the aircraft is empty. Quite apart from the risk involved to the crew, the risk to the public on the ground is in my judgment quite indefensible. In my opinion, in addition to stipulating a minimum rest time before a public transport flight and a maximum flight time for that flight a minimum rest time must also be stipulated after it and before any other flight whatever. I understood from counsel for H.M. Attorney-General that he did not dissent from this view.

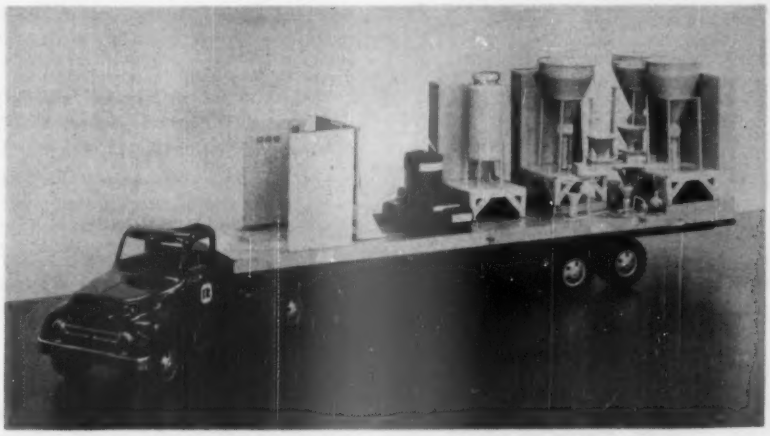
Risk Warning

In the course of opening the case, H.M. Solicitor-General invited me to find that the practice of seeking navigational guidance outside the service range of the wanted signal is undesirable. I agree, and I would invite consideration to the best method of warning pilots of the risks involved. Assuming a pilot is warned of the risk and is accordingly taking care to check the accuracy of the guidance he is receiving from his ADF equipment by the other methods available to him, I see no reason why he should not tune to a beacon from outside its strict service range. The danger, in my opinion, really arises when he does this without appreciating the risk he is running if he fails to tune accurately or check the results by the other methods available to him.

The above recommendation will of course be largely obviated if effect were given to the recommendations contained in the report of July 29, 1958, (C.A.P. 152) on the accident to Bristol Aircraft G-AICS.

Article (17(8) of the Air Navigation Order, 1954, provides:

(a) As soon as a certificate of maintenance in respect of an aircraft registered in the United Kingdom which carries or is intended by the operator for carrying passengers or goods for hire or reward is issued, the operator of the aircraft shall provide a book (in this Order referred to as a "record of defects") for the purpose of recording defects in the aircraft occurring during the period of vadility of such certificate of main-



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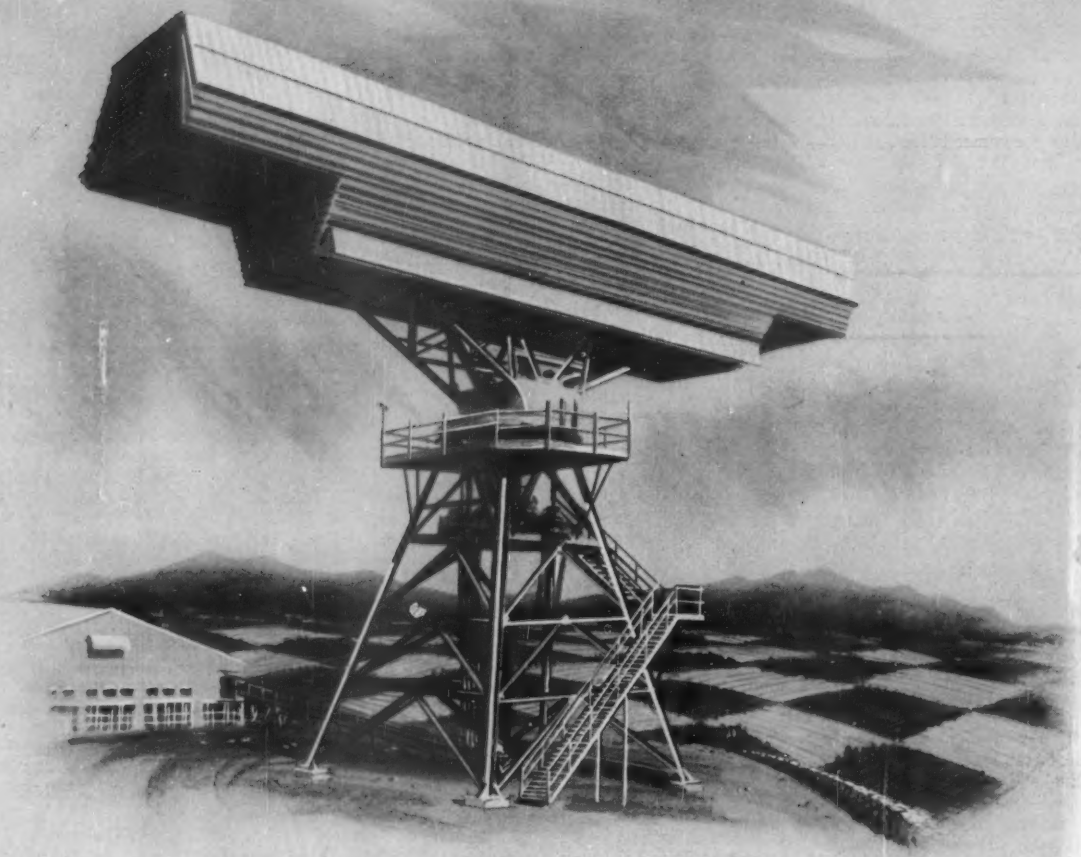

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Sikorsky HSS-2 Conducts ASW Tests

U. S. Navy anti-submarine warfare avionics gear tests are conducted by a Sikorsky HSS-2 twin turbine helicopter over Long Island Sound. Sonar ball is retracted into a well in the aircraft's under-fuselage; protuberance under figure "9" is UHF antenna.

tenance and the rectification of such defects.

(b) On the termination of every flight the person in command of the aircraft shall enter in the record of defects (1) particulars of any defects in the aircraft including its engines, components, accessories, instruments, equipment, apparatus and their installation observed by him during the flight or reported to him, or (2) if no such defect has been observed by him during the flight or reported to him, a statement to that effect and shall sign and date such entry.

(c) After rectifying any such defect in the aircraft the person effecting such rectification shall enter in the record of defects particulars of such rectification and shall sign and date such entry.

(d) The operator shall either preserve each entry in the record of defects for a period of two years after the expiration of the period of validity of such certificate of maintenance or shall, as soon as is reasonably practicable and in any case within six months of the expiration of such period, cause a copy of the entry to be made in the aircraft log book, engine log book or propeller log book, whichever is appropriate, kept in respect of the aircraft.

(e) If no copy of an entry is made in the appropriate log book, the operator shall, as soon as is reasonably practicable and in any case within six months of the expiration of the period of validity of such certificate of maintenance, cause particulars sufficient to identify the entry to be written in such log book.

Article 20(6) defines a "flight" as follows: "Flight includes the whole of the period occupied in transit from an aerodome to the aerodome of next landing from the time when the aircraft is first in motion on the ground until the time when it comes to rest on landing."

Records Lost

As counsel for the Air Registration Board agreed the whole object of Article 17(8) is to ensure the making of the appropriate entry after each flight as defined and the preservation of the record of defects for a period of two years. Obviously this is defeated if instead of an entry being made after each flight it is only made when the aircraft returns to base or if, although made at each landing, no duplicate is left on the ground so that in the event of a crash all record is lost. In this case, if any record was made of the work done at London Airport, this vital evidence was lost.

Having listened to the evidence and, in particular, that of Mr. Norman Ebbutt, the technical director of the company, I have no doubt that the practice of the company was to send on a flight an engineer who was in most cases not licensed to certify any work of maintenance or rectification to the aircraft. Any work done by this man was normally certified, if at all, only when the aircraft returned to base when a licensed engineer would discuss with him what had been done and then sign the appropriate certificate.

In rare cases no doubt the services of a licensed engineer available locally were made use of, or a licensed engineer was flown from the company's base to the airport where the aircraft was grounded, but the usual practice once an aircraft had left base was to put the responsibility on the pilot to decide whether to get local help or call for assistance from base with the result that in the ordinary way the unlicensed man did the work and the aircraft then continued its journey.

Ebbutt appeared to justify this practice by

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an argument based on the proviso to Regulation 49 of the Air Navigation (General) Regulation 1954, designed to cover the carrying out of temporary repairs in emergency. The regulation does not define "emergency." His argument was that once an aircraft had left its base it was "en route" and accordingly any repairs could on the authority of the captain be treated as arising in emergency and be carried out by the unlicensed engineer and certified on return to base. Thus he suggested that having reached London Airport on Sept. 1 the aircraft was "en route" and it was quite proper on the authority of the captain for unlicensed engineers to effect repairs in the "emergency" and for the aircraft then to fly out to Tel Aviv and back as scheduled.

It is, of course, when an aircraft has crashed that the record of defects any of any work of maintenance or rectification is of most importance. If Article 17(8) is to be of real value in such circumstances it is, I think, essential that a duplicate of each entry made after a flight should be left on the ground and that the requirement that the entry shall be made after each flight should not be avoided under the pretext that the circumstances constitute an emergency. It is perhaps even more important that, if an aircraft has to be repaired by an unlicensed engineer in circumstances which constitute a true emergency, it should not thereafter be flown further than to the nearest airport where the work done can be properly inspected and certified.

I would therefore recommend:

(1) That in the case of the current record of defects any necessary amendment should be made to require that this record shall be completed in duplicate at the termination of each flight as defined by Article 20(6) and that in each such case one copy only shall be carried in the aircraft and that arrangements shall be made to ensure the preservation of the record for two years.

It may be useful to compare the practice in regard to load sheets where one copy is left on the ground. See Article 28 (4) (c) of the Air Navigation Order 1954 as contrasted with Article 28 (6) (c).

(2) The word "emergency" in the proviso to Regulation 49 should be defined as applying only to circumstances where an aircraft for some reason beyond the control of the operator or crew lands at an airport where facilities do not exist to enable the requirements of Regulation 49 to be complied with and as extending only to a flight from that airport to the nearest airport at which such facilities exist.

Radio, Radar Ruling Requested by FAA

Washington—The Federal Aviation Agency has proposed a new ruling requiring agency approval of all airborne radio and radar equipment installed on aircraft operated by scheduled and supplemental airlines.

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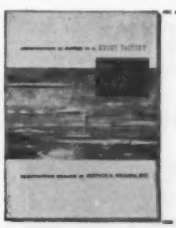

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(*Continued from page 23*)

Changes

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Jack Katzen, manager-engineering administration and integration, General Electric Co.'s Missile and Space Vehicle Department, Philadelphia, Pa. Also: **Otto Klima,** manager of a systems engineering operation.

Thomas A. McDougall, manager of project development, Lockheed Aircraft International, Los Angeles, Calif.

S. George Lawson, operations manager, Semiconductor Division, Sylvania Electric Products, Inc., Woburn, Mass.

Casper J. Breuer, director of administrative operations, and **Bernard Berman,** director of program operations, Ramo-Wooldridge, a division of Thompson Ramo Wooldridge, Inc., Los Angeles, Calif.

George A. Rodney, director of the Test Division, The Martin Co.'s Denver, Colo., Division. Also: **Raymond E. Geller,** manager, Base Systems Department, Engineering Division; **Thomas P. Tierney,** director of industrial relations.

Edward R. Corvey, deputy director of planning, American Machine & Foundry Co., New York, N. Y. Also: **J. D. Graves,** acting general manager of the company's Alexandria, Va., Division, replacing Mr. Corvey.

Joseph L. Dickey, manager-Bomarc missile seeker project, Air Arm Division of Westinghouse Electric Corp., Baltimore, Md.

Clarence S. Sorenson, manager of customer relations, Aetron Division, Aerojet-General Corp., Covina, Calif.

John W. Dixon, manager of long-range planning, Convair (San Diego) Division of General Dynamics Corp., San Diego, Calif.

Sanford Davis, manufacturing manager, The Garrett Corp.'s Air Cruisers Division, Belmar, N. J.

Joseph Carlstein, chief engineer, Ketay Department, Commack, N. Y., of the Norden Division of United Aircraft Corp.

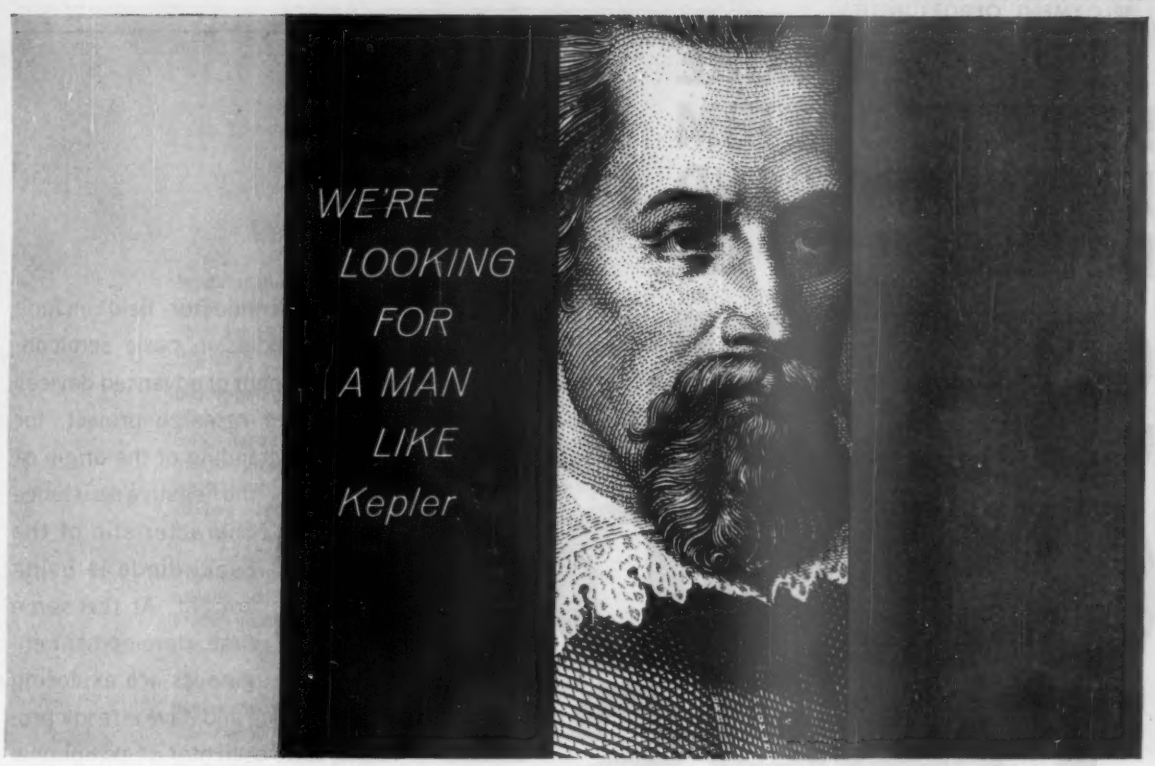
Dr. Charles L. Register, program manager-ALRI (airborne long range input) USAF contract, Burroughs Corp., Detroit, Mich. **Knox McIlwain** succeeds Dr. Register as manager of Burroughs' Great Valley, Pa., Laboratories.

Jack L. Bromberg, program manager-Nike Zeus activities, Douglas Aircraft Co., Inc., Santa Monica, Calif. Also: **Paul Swan,** assistant Zeus program manager.

Anthony Del Duca, chief engineer, Metrolog Corp., a division of Air Logistics Corp., Pasadena, Calif.

V. M. Bennett, program manager-Army projects, Ryan Electronics, a division of Ryan Aeronautical Co., San Diego, Calif. Also: **Arthur H. Attebery,** chief of engineering services.

Dr. J. R. McCaughna, director of electronics research and development, Broadview Research Corp., Burlingame, Calif.



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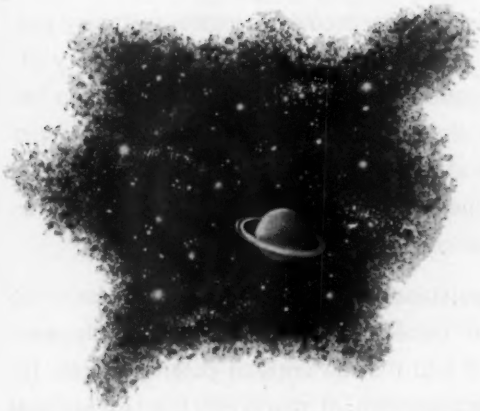

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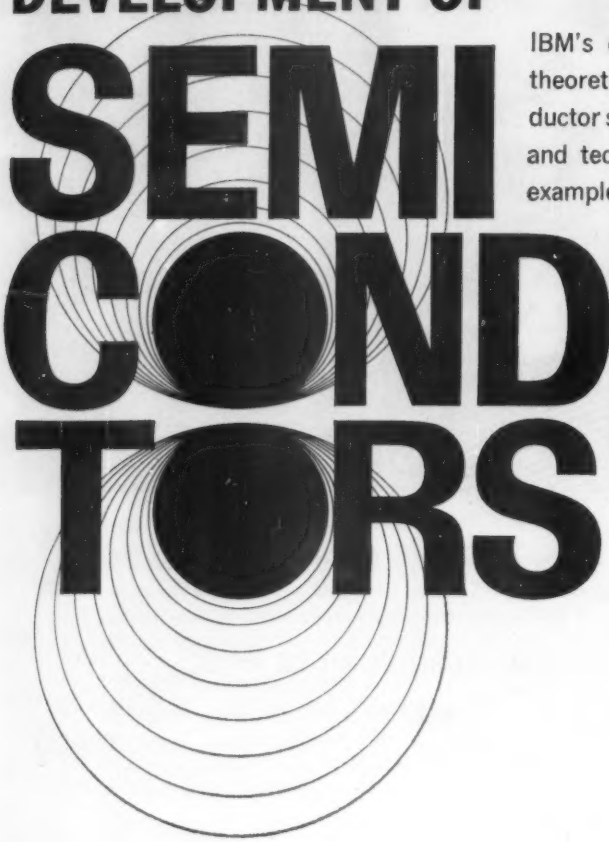

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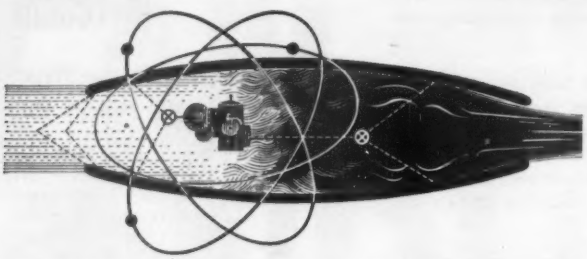

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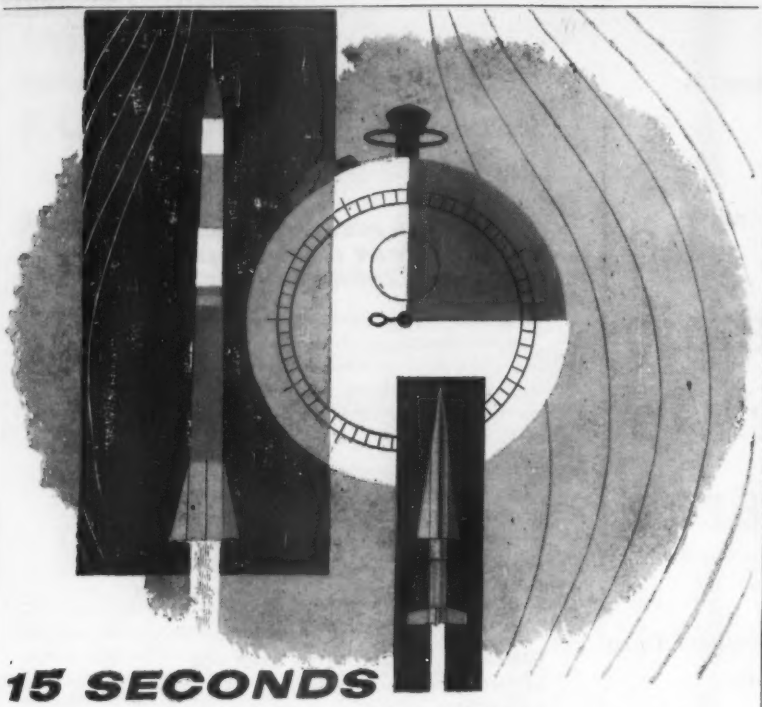

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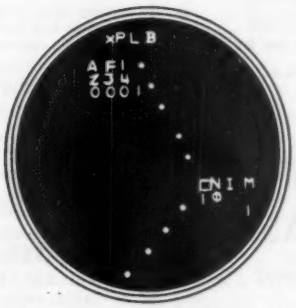

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LETTERS

Tip Vortices

In reference to the recent lightplane accident report in your magazine concerning the effects of wingtip vortices of C-124 aircraft (AW Nov. 9, p. 133), careful perusal of the report failed to disclose any recognition further "blunted" by the wingtip heater pod. Also, these heaters dump exhaust gases directly into the wingtip air slipstream.

I have no idea of how much or how little the presence of these heaters and effluent hot gases would affect the dimensions, intensity, and tenure of post aircraft passage wingtip vortices. It is possible, however, that in stable air these vortices may take on a self-generating turbulence which would far exceed the time and scope of the current "leeway" considerations given by private pilots.

Any further ideas on this subject?

JOHN P. MEAGHER
Lusby, Md.

Job Survey

My compliments to you on your report of the job survey in the Nov. 16 issue (p. 123). I am pleased to be assured that my failure to get response from personnel administrators on job applications has not been entirely due to my own shortcomings. Although my background includes a Master of Science degree in engineering and two years' experience, I found it necessary to join the first company which would offer a job—one for which I am not properly trained.

ELECTRICAL ENGINEER
Los Angeles, Calif.

Congratulations on the article in the Nov. 16 issue (p. 123) concerning recruiting practices! I find that AVIATION WEEK shows more attention to the professional status and effective use of engineers than do any of the publications of the three "professional" engineering societies to which I belong. If the larger companies were really to use effectively all the engineering talent they already have on board, not only could they stop recruiting, they could release half the people they now have.

I suggest that the so-called personnel men find trips to all parts of the country to make first contacts more interesting and enjoyable than the routine follow-up and the real personnel work needed to keep people.

MERVIN E. FRANK
Beverly Hills, Calif.

The runaround that employers give to scientist-engineer applicants may be a part of the Great Leveling Process—but only insofar as everybody gets treated about the same way. The employer who gives the runaround to engineers and scientists also gives the same runaround to every other sort of applicant.

There is no wall of misunderstanding between the technologically advanced on the one hand and administrative personnel on the other. It is true, of course, that administrative personnel sometimes get tired of the pretentious manner in which scientists use the cant phrases of their profession to try to make it seem mysterious, but there is no lack of understanding. On the contrary, in my firm our engineers are not pretentious and our administrative people are not jealous of them, and the result is that we have pretty good mutual understanding.

Where a runaround is given it is basically due to the indecisiveness of top management and the unwillingness of top management to provide the personnel executive with the necessary staff with which to treat applicants at least as well as the sales department treats customers. One hears of many instances in which a recruiter oversells his company, or overfills his quotas; cases in which a department head offers employment and then has to retract the offer because top management changed its mind; and on and on. Keeping up with the gyrations of planners who determine manpower requirements by "scientific" means sometimes drives personnel men crazy. The plain truth is that in the recruiting of personnel, as in nearly everything else, you are forced to wonder how the average large organization manages to stay in business.

I recently had occasion to use your publication in order to advertise for certain non-technological personnel, and was pleased to note that with every answer you sent us you included a printed slip to the effect that we should show the applicant the minimum courtesy of acknowledging his application. We didn't need the reminder, but we were glad to see it anyhow.

INDUSTRIAL RELATIONS MANAGER
Miami, Fla.

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Pilot Physicals

In Mr. Trimble's rebuttal to Robert Cook's story (AW Nov. 23, p. 150), there is one fact of which he is apparently not aware and that is the laxity in the six-month physicals that airline pilots undergo.

Being an airline pilot myself, and a supporting member in good standing of ALPA, I cannot condone some of the semi-annual trips to the flight surgeon that have become known as rigid physical standards for airmen. After a recent such examination, I objected violently to the examiner for having learned so little about my own well being for the $15 fee. Needless to say, this, my first visit at this particular production mill, was reported to the FAA. Acquaintances of mine are known to travel from one coast to the other twice yearly to assure themselves of passing a Class I. True enough, years alone are not adequate criteria for determining the fitness of a pilot, but without mature responsibility on their part, and that of the examiner, it is the only protection the public has. The recently established requirement for electro-cardiographs was a big step forward, but far from the complete answer.

AIRLINE PILOT
Marietta, Ga.

Cal Tech Chief

May I suggest the desirability of a little more accuracy in your Washington Roundup of Nov. 23. My boss President Lee A. DuBridge would probably be even more surprised than I to learn that Millikin (sic) was president of Cal Tech.

CLARK B. MILLIKAN
Professor of Aeronautics
California Institute of Technology

(AVIATION WEEK's apologies to President DuBridge and Prof. Millikan, also to Dr. Jerome Wiesner who is a director of Hermes Electronic Corp., not Raytheon, and Dr. Emanuel Piore who is research director of Int'l. Business Machines Corp.—Ed.)

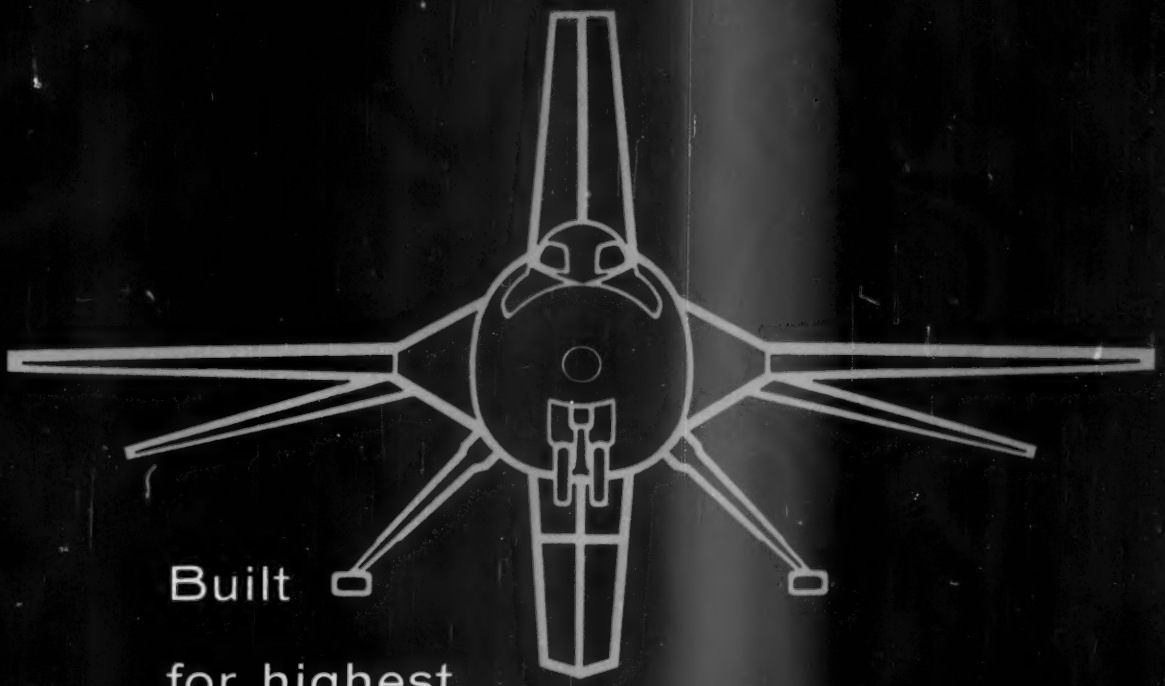
Patent Paradox

Why should corporations object to working under rules that they have imposed on their employes for years? I found the situation reported in "NASA Issues New Regulations On Space Act Patent Waivers" by Craig Lewis (AW Nov. 16, p. 39) to be rather paradoxical. The corporation, when working for NASA, under contract, and with its activities directed by NASA, fails to see why it should surrender its patent rights to the government. Yet this same corporation, when employing an engineer, makes employment conditional upon the surrender by the employe of his patent rights on any invention conceived while working under contract with and with direction from the corporation.

I think that any relaxation of the rules concerning patents under NASA contract should be made under this provision—that any changes in the patent relation between NASA and the corporation shall also apply to the patent relation between that corporation and its employes.

An idea or an invention cannot be conceived by a government agency, nor by a corporation, but only in someone's mind. It seems equitable to make a patent public property when the work of invention is financed with public funds and it is in the national interest to do so. If the government must grant economic leverage, in the form of a patent, it should be to the person who conceived the idea. It should not be granted to the corporation which forced that person to surrender his patent right under the same circumstance and with the same relation as the government now has with the corporation engaged in NASA work.

JOHN F. PETERS
Los Altos, Calif.



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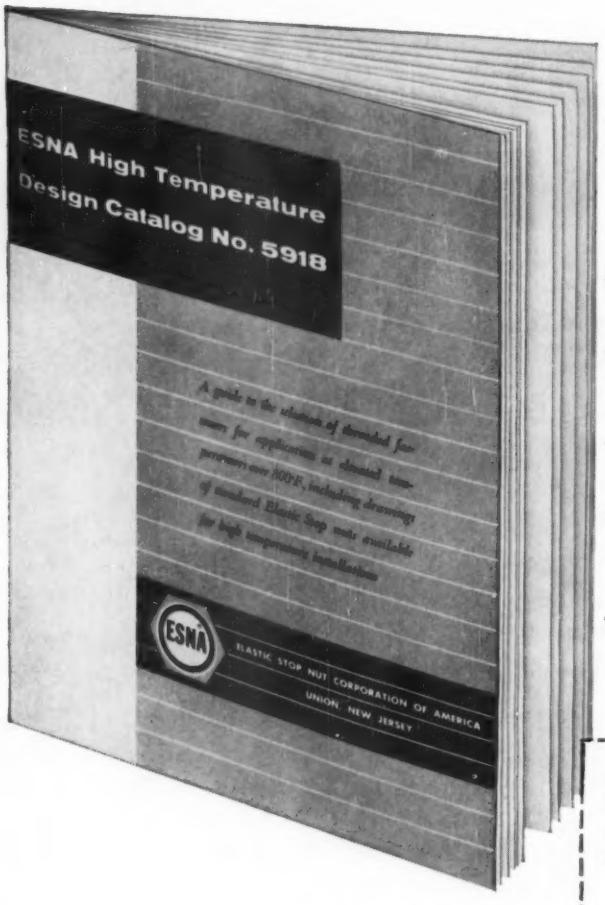

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